STEEP32 COMPUTER CODE

FINAL REPORT

W. S. Goerke

Prepared for

National Aeronautics and Space Administration
GEORGE C. MARSHALL SPACE FLIGHT CENTER
Marshall Space Flight Center, Alabama 35812
Contract No. NAS8-25918

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ABSTRACT

This report is a manual to aid in using the STEEP32 code. STEEP32 is the EXEC VIII version of the STEEP code (STEEP is an acronym for Shock Two-dimensional Eulerian Elastic Plastic). The major steps in a STEEP32 run are illustrated in a sample problem. There is a detailed discussion of the internal organization of the code including a description of each subroutine.

LIST OF SYMBOLS

d_{ij}	Deformation rate tensor.
d^*_{ij}	Deviatoric components of the deformation rate.
σ_{ij}	Stress tensor.
S_{ij}	Deviatoric components of stress.
t	time.
Y	Static yield strength in uniaxial stress.
ϵ_p	Generalized plastic strain.
ρ	Density.
μ	Shear modulus
ω^i_j	Spin tensor.
$\phi(F)$	Rate sensitivity material function.
γ	Rate sensitivity parameter.
e	Specific internal energy.
M	Mass.

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SECTION 1

INTRODUCTION

STEEP32 is a modification of the STEEP code initially developed under NASA contract NAS8-20235. Under the current contract STEEP has been made compatible with the EXEC VIII system at Marshall Space Flight Center. The name STEEP is an acronym for Shock Two-dimensional Eulerian Elastic Plastic. The suffix 32 was added since the EXEC VIII version of STEEP is restricted to using less than 32K words of storage.

The development of the basic Eulerian method used in STEEP is described in Reference 1 and in Appendix D of Reference 2. Subsequent to the initial development, the formulation was generalized to include strain rate effects on material properties. A discussion of the strain rate formulation and an analysis of scaling relationships in hypervelocity impacts appears in Reference 2. An application of STEEP to the study of debris formed by hypervelocity impacts on thin plates is described in Reference 3. Comparisons between STEEP solutions and dynamically-instrumented experiments confirming the accuracy of the code are made in Reference 4.

The documentation of STEEP 32 concentrates on the data processing since a thorough description of the mathematical formulation already appears in References 1 and 2. However, formulas in these documents are frequently cited to correlate the mathematics with the code.

SECTION 2

ORGANIZATION OF STEEP32

The simulation of a STEEP32 problem takes place in three stages. These are initial conditions, integration, and edit. The body of computer programs associated with each of these operations is referred to as a processor.

The initial conditions, integration, and edit processors communicate to one another through information carried on magnetic tape. Each block of such information is called a restart file. Thus the initial conditions processor writes a restart file which in turn acts as part of the input to the integration processor. Each execution of the integration processor writes at least one restart file which in turn serves as data to subsequent integration or edit runs.

In the following three sections the sequence of operations within each of the main processors of STEEP32 is discussed.

2.1 INITIAL CONDITIONS

The initial conditions processor first uses subroutine DATA to read the namelist INITAL. This namelist contains all the data for initial conditions other than that associated with the boundary string. The next activity of initial conditions is the grid generation. During this phase of the computation subroutine GRIDVT uses the information in NETBLK to generate the grid variables in common block RCDATA.

Subroutine GENBND is next used to generate the string information. The data associated with the string is in the namelist BDSTRG. Using the string information and grid coordinates subroutine MOVER calculates the area and volume data. Subroutine REGION completes the calculations by computing the initial values for the cell variables in the common block GRDATA.

Initial conditions terminates by making a pass over the drum to produce print and restart files. The process is controlled by subroutine OUTPUT.

2.2 INTEGRATION

The first activity of the integration processor is RESTART. Following restart the namelist DATAL2 is read to modify the values that were on tape. This is done by subroutine DATA2.

The actual computations during integration take place in three stages. The first stage is controlled bv subroutine COMP1. This stage of the computation is sometimes referred to as the "no flow" portion of the intergration since only estimated quantities are calculated. COMP1 makes one pass over the drum. During this stage of the calculations the string points are moved.

The second stage of the integration computations is the boundary string calculations. During this process the updated locations of the string points are used to obtain new areas and volumes. As with initial conditions the subroutine which controls these calculations is MOVER.

The final stage of the computations is controlled by subroutine COMP2. During this stage the drum file created by COMP1 is used to perform the "flow" calculations and produce the final values of the cell variables of the current cycle.

The following two charts illustrate the staging of calculations within COMP1 and COMP2. Note that COMP1 requires that there be five column buffers but COMP2 needs only four.

2.3 EDIT

The edit processor produces SC4020 plots in two stages. The first stage draws the background information. This consists of a grid, x and y labels and heading information. The background is controlled by subroutine PAPER.

The second stage of the edit processor draws the foreground information. This process is controlled by subroutine FUNCT. During the second stage one pass is made over the scratch drum file.

The creation of SC4020 edits from STEEP32 is also a function of the MSFC SC4020 library. Since this library is still in a state of flux, it is recommended that anyone using this part of STEEP32 should remain sensitive to changes being made by the systems staff.

STAGING OF CALCULATIONS COMP1

Routine Called	Do Index IC	SWRITE	SREAD	PHASEA	HYPOEL	Incomplete SIO Reading	Incomplete SIO Writing
SOPEN						*LIMIN*	
SREAD	LIMIN		LIMIN			+1	
SREAD PHASEA	+ 1		+ 1	+1		+2	
SREAD PHASEA HYPOEL	+ 2		+ 2	+ 2	+1	+3	
SWRITE SREAD PHASEA HYPOEL	+ 3	LIMIN	+ 3	+3	+ 2	+ 4	LIMIN
SWRITE SREAD PHASEA HYPOEL	+ 4	+ 1	+ 4	+4	+ 3	+ 5	+ 1
			ETC.				
SWRITE SREAD PHASEA HYPOEL	LIMAX-1	LIMAX-4	LIMAX-1	LIMAX-1	LIMAX-2	LIMAX	
SWRITE SREAD PHASEA HYPOEL	LIMAX	LIMAX-3	LIMAX	LIMAX	LIMAX-1	EOF	LIMAX-3
SWRITE HYPOEL	+ 1	- 2			LIMAX		-2
SWRITE	+ 2	- 1					-1
SWRITE	+ 3	LIMAX					LIMAX
SCLOSE	-	EOF					EOF

STAGING OF CALCULATIONS COMP 2

Routine Called	*Do Index* IC	*SREAD*	*STRFLO*	*MASFLO*	*STRESS*	*SWRITE*	*Incomplete* SIO Reading	*Incomplete* SIO Writing
SOPEN							LIMIN	
SREAD	LIMIN	LIMIN					+ 1	
SREAD STRFLO MASFLO	+ 1	+ 1	LIMIN	LIMIN			+ 2	
SREAD STRFLO MASFLO STRESS SWRITE	+ 2	+ 2	+ 1	+ 1	LIMIN	LIMIN	+ 3	LIMIN
SREAD STRFLO MASFLO STRESS SWRITE	+ 3	+ 3	+ 2	+ 2	+ 1	+ 1	+ 4	+ 1
			ETC.					
SREAD STRFLO MASFLO STRESS SWRITE	LIMAX-1	LIMAX-1	LIMAX-2	LIMAX-2	LIMAX-3	LIMAX-3	LIMAX	LIMAX-3
SREAD STRFLO MASFLO STRESS SWRITE	LIMAX	LIMAX	-1	-1	-2	-2	EOF	-2
STRFLO MASFLO STRESS SWRITE	+ 1		LIMAX	LIMAX	-1	-1		-1
STRESS SWRITE	+ 2				LIMAX	LIMAX		LIMAX
SCLOSE						EOF		EOF

SECTION 3

AN ELEMENT BY ELEMENT DESCRIPTION OF STEEP32

To the EXEC VIII system each of the main processors of STEEP32 is a distinct program file made up of individual elements. In EXEC VIII there are four types of elements:

(1) Procedure elements.

(2) Source language elements.

(3) Relocatable binary elements.

(4) Absolute binary elements.

Since the last two types of elements are produced from the first two, they will not be discussed further.

Procedure and source language elements can be either assembler, COBOL, or FORTRAN. There can also be COLLECTOR source elements. In STEEP32 only three types of elements occur:

(1) FORTRAN procedure elements.

(2) FORTRAN source elements.

(3) COLLECTOR source elements.

The STEEP32 elements are described in the following pages according to their type.

3.1 FORTRAN PROCEDURE ELEMENTS

The FORTRAN procedures or PROC's currently in STEEP32 are used for two purposes. The first use is to define the values for the PARAMETERS. These PARAMETERS serve mainly to allocate space for larger arrays used by STEEP32. By changing the values of the PARAMETERS in these PROC's and recompiling the FORTRAN source code, it is possible to tailor the amount of core required to the needs of the particular problem being simulated.

The second use of the procedures is to define frequently appearing common blocks. Using procedures in this fashion eliminates the need to have a copy of a common block for each subroutine using it. In addition to the common blocks, these procedures may also contain INTEGER, REAL, or LOGICAL statements for variables in the common block. It is important to note that a common block which appears in a procedure may also still be referenced explicitly in some of the older subroutines.

On the following pages each procedure is documented. The description of the procedures containing common blocks is brief since the common blocks themselves are documented in a separate section.

PROCEDURE PARAM

PARAM contains the parameters defining the dimensions of a majority of the arrays in STEEP32.

Parameter	Description
NUMROW	The maximum number of rows a problem can have.
NUMCOL	The maximum number of columns a problem can have.
NUMCEL	The maximum number of cells.
NUMGSC	The number of columns in core that are used for scratch purposes. NUMGSC is currently set to 5 and this value should never change.
NUMCUT	The number of cell variables.
NUMRDT	The number of row variables in RCDATA.
NUMCDT	The number of column variables in RCDATA.
NUMRTP	The number of row temporary words.
NUMCTP	The number of column temporary words.
NUMSTG	The maximum number of boundary strings.
NUMSTR	The maximum number of string points.
NUMCUT	The maximum number of cut cells.
NUMCTY	The maximum number of cell types.
NUMSTY	The maximum number of segments per cell.
NUMHED	The number of header words.
NUMCOE	The number of coefficients for artificial viscosity.

Procedure PARAM continued.

Parameter	Description
NUMMSK	The number of masks in dictionary word.
NUMPCN	The maximum number of PCON constants.
NUMMAT	The number of materials. This must always be 1.
NUMCSG	The maximum number of cuts per string segment.
NUMREG	The maximum number of regions used to define initial conditions.
NUMXYS	The maximum number of X, Y groups which may be used to specify grid.

PROCEDURE PARAMB

PARAMB contains the parameters used to define the dimension of those arrays used exclusively for the SC4020 edits.

Parameter	Description
NUMSCG	The maximum number of SC4020 graphs.
NUMWDH	The maximum number of words for labels.
NUMTIT	The maximum number of words for title.
NUMDEP	The maximum number of deposition bins.
NUMSPC	The maximum number of contour values used in table.
NUMCON	Maximum number of contour values used in labeling the contours.

PROCEDURE BOUCOM

BOUCOM contains the common block BOUNDY and several type statements. Thus it contains all the variables associated with the string and the string points.

PROCEDURE CONCOM

CONCOM contains the common block CONSTS and several type statements for variables in CONSTS. In addition, CONCOM defines an array ALLCOM which is equivalenced to CYCLE. This is to make it easy for subroutine FILE to write the contents of CONSTS onto the restart tape.

PROCEDURE CUTCOM

CUTCOM contains the common block CUTBLK. This holds all the information about partially filled cells.

PROCEDURE GDACOM

GDACOM contains all the scratch area for the cell variables. In addition to a type statement GDACOM also defines a number of arrays which are in turn equivalenced to an appropriate location of GDATA. This makes it possible to reference any of the cell variables by use of a single subscript.

PROCEDURE MATCOM

MATCOM contains the common block MATBLK and a type statement for the logical variable VONMIS.

PROCEDURE RCDCOM

RCDCOM contains the common block RCDATA. RCDCOM also defines several arrays which it equivalences to appropriate parts of variables in RCDATA. This allows for single subscripts in those subroutines which must have acess to the grid information.

PROCEDURE SENCOM

SENCOM contains the common block SENSWT which used to hold the values of the first six sense switches. All references to SENCOM are believed to have been removed.

PROCEDURE SUBCOM

SUBCOM contains common block SUBSBK. This is all the subscript information necessary to reference any of the cell or grid variables.

PROCEDURE SHHCOM

SHHCOM contains common block SHCOM which defines the strain hardening information. SHHCOM also includes the type statement for the logical variable SF.

3.2 FORTRAN SOURCE ELEMENTS

The majority of elements in the STEEP32 code are FORTRAN V source elements. Several of these elements such as BET and IBET were originally written in the SLEUTH assembly language for the EXEC II system. Those elements were changed to FORTRAN to avoid the possibility of encountering incompatibilities between the EXEC II and EXEC VIII assemblers. Other elements such as GEDATE and GETIME were originally written in SLEUTH to extract special words from the EXEC II resident. These are now dummy FORTRAN subroutines. Routines serving similar purposes should be obtainable from the EXEC VIII system library or staff.

The following pages document the FORTRAN source elements. Under the heading "Element Description" the code is related to the mathematics described in several publications. Each element's role in the data processing is also described.

Under "Abort Conditions" the references to subroutine ABORT are described. The first word of the description appears in all capital letters. ABORT prints this word preceded by the words "ABORT CALLED BY" when it is called. STEEP32 calls subroutine ABORT when it detects an illogical situation occurring.

The section entitled "Messages to Printer" describes what effect each subroutine has on the print file.

Element Name: ABORT Element Type: FORTRAN Subroutine

Entry Points: ABORT

Called By: ARECEL, BDNORM, BDSTRS, GENBND, GRIDVT, INTRST, PUTGET, SETMAT, SETSEG, SETSID, SETSUB, SIO, VOLCEL, BDMOVE, COLPTS, SELDT, STRESS, GETCON, PLASFL, ISOMET, FXVSFY, MASSES, PLOTTR, CONTUR

External References: None

Common Blocks: IOCNTL, SUBSBK

Calling Sequence: ANAME

Processor: I.C.

Variable	Description
ANAME	1 word alphanumeric description of the type of call.

Element Description: ABORT terminates via an illegal computed GO TO. This forces a dump if the "PMD" card is present.

Abort Conditions: None

Message to Printer: ABORT CALLED BY ANAME

Element Name: ARECEL Element Type: FORTRAN FUNCTION Subroutine

Entry Points: ARECEL

Called By: PRNTIJ, VOLCEL, SETFOR

External References: GETCON, SAVSUB, GETIJ, ABORT

Common Blocks: CONSTS, SUBSBK, CUTBLK, RCDATA

Calling Sequence: L, MODE

Variable	Description
(1) L	Legal Subscript to Cell Dictionary.
(2) MODE	= 1, A Regular Cell is Assumed. = 2, A Stress Cell is Assumed.

Element Description: ARECEL calculates the area of a material lying in either a regular or stress cell.

Abort Conditions: ARECEL - If the value in the cell dictionary is not a positive number.

Message to Printer: None

Element Name: ARVOL Element Type: FORTRAN Subroutine

Entry Points: ARVOL

Called By: BDNORM, BDSTRS

External References: ATAN2

Common Blocks: None

Calling Sequence: (XT, YT, IT, XS, YS, IS, JS, ISIDE, XSIDE, AREA, VOL)

Variable	Description
IT	Number of string points and intersections of the string with the boundary.
XT, YT	Coordinates of the string.
XS, YS	Location of the sides of the cell.
IS, JS	Subscripts of the cell.
ISIDE, XSIDE	Initial and final sides which are being cut by the string.
AREA, VOL	Output variables.

Element Description: ARVOL uses line integrals to calculate the area and volume of the material bounded by the string points lying in a cell.

Abort Conditions: None

Messages to Printer: None

Element Name: BDINIT Element Type: FORTRAN Subroutine

Entry Points: BDINIT

Called By: MOVER

External References: GETCON, PUTGET, PUTCON, INTPSH

Common Blocks: CONTS, BOUNDY

Calling Sequence: None

Variable	Description

Element Description: BDINIT initializes the space associated with the boundary push down list. In the dictionary it replaces time N information with time N + 1 information.

Abort Condition: None

Message to Printer: None

Element Name: BDMOVE Element Type: FORTRAN Subroutine

Entry Points: BDMOVE

Called By: COLPTS

External References: EXTRAP, EXIST, SETSUB, ABORT, MASSIJ

Common Blocks: CONSTS, SUBSBK, GRDATA, RCDATA, IOCNTL

Calling Sequence: $,IM, JM, LIM, LJM, XM, YM

Variable	Description
$	Nonstandard return.
IM, JM	I,J coordinates of regular cell that string point is in.
LIM, LJM	I,J coordinates of lattice cell that string point is in.
XM, YM	X,Y coordinates of string point.

Element Description: BDMOVE moves any string point which is found to exist in a column. The double interpolation scheme used is described on page 27 of Reference 1, however, the mass terms have been deleted from the equations 3.35. The nonstandard return is taken if no cell surrounding the string point exists.

Abort Conditions:

BDMV.1 - The denominator in equations 3.35 is zero.

BDMV.2 - A string point is outside the extremum of the problem.

Messages to Printer: None

Element Name: BDNORM Element Type: FORTRAN Subroutine

Entry Points: BDNORM

Called By: BDNORM

External References: ENCLOS, CHOOSE, SETSUB, ABORT, SETSEG, INTRST, ARVOL, STARVL

Common Blocks: SUBSBK, RCDATA, BOUNDY, NTRACT

Calling Sequence: (SI, SJ, X, Y)

Variable	Description
SJ, SI	Cell subscripts of cell being worked with.
X,Y	Initial intersection point coordinates.

Element Description: BDNORM collects the string points in a regular cell. It calls INTRST to determine the intersection of the string with the cell sides. It then calls ARVOL to determing the area and volume of the regular cell.

Abort Conditions: BDNORM - If the point (X,Y) does not lie on one of the four cell-sides.

Messages to Printer: None

Element Name: BDPOST Element Type: FORTRAN Subroutine

Entry Points: BDPOST

Called By: MOVER

External References: GETCON, SETSUB, SETSID, FILLER, SETMAT

Common Blocks: RCDATA, BOUNDY, CONSTS, SUBSBK, SCANBK, CUTBLK

Calling Sequence: None

Variable	Description

Element Description: Subroutine BDPOST cleans up the remaining items at the termination of processing the boundary. A scan is made over the areas and volumes of the cells to see whether the cut areas and cut volumes are indeed very close to the total areas and total volumes, in which case the total areas and total volumes are substituted for cut areas and cut volumes. This is done for both regular cells and stress cells. An additional computation prohibits cut cell areas and volumes from exceeding the magnitude of the actual cells. Following this sequence of computations a series of calls to SETSID is made in order to set horizontal and vertical lattice segment types and cell segment types in the remainder of the dictionary. Finally a call to subroutine FILLER and a call to subroutine SETMAT are made to complete the dictionary.

Abort Conditions: None

Messages to Printer: None

Element Name: BDSTRS Element Type: FORTRAN Subroutine

Entry Points: BDSTRS

Called By: BONDPR

External References: ENCLOS, CHOOSE, SETSUB, ABORT, SETSEG, INTRST ARVOL, STARVL

Common Blocks: SUBSBK, RCDATA, BOUNDY

Calling Sequence: SI, SJ, X,Y

Variable	Description
SI,SJ	Cell subscripts of cell being worked with.
X,Y	Initial intersection point coordinates.

Element Description: Same as BDNORM only for stress cells.

Abort Conditions: BDSTRS - If the point (X,Y) does not lie on one of four sides of the lattice cell.

Messages to Printer: None

Element Name: BET Element Type: FORTRAN FUNCTION

Entry Points: BET

Called By: ENCLOS, LINES, TBFTO2, LNEDIT, CONTUR

External References: None

Common Blocks: None

Calling Sequence: A, X, B, M

Variable	Description
A	First test argument.
X	Second test argument.
B	Third test argument.
M	Dummy argument

Element Description: Routine checks if X is between A and B. See description of IBET.

Abort Conditions: None

Messages to Printer: None

Element Name: BONDPR Element Type: FORTRAN Subroutine

Entry Points: BONDPR

Called By: MOVER

External References: FOLTES, PACUNP, BDNORM, BDSTRS

Common Blocks: CONSTS, BOUNDY, IOCNTL

Calling Sequence: None

Variable	Description

Element Description: BONDPR is the driving routine for boundary processing. It calls BDNORM and BDSTRS to calculate the areas and volumes of regular and stress cells respectively. FOLTES is called to check for a string fold condition.

Abort Conditions: None

Messages to Printer: None

Element Name: BOUNST Element Type: FORTRAN Subroutine

Entry Points: BOUNST

Called By: SETFOR

External References: None

Common Blocks: GRDATA, SEGBLK

Calling Sequence: L, A, B, C

Variable	Description

Element Description: BOUNST determines the stresses at a point of cut in a regular cell. Currently BOUNST returns the stresses indexed by L.

Abort Conditions: None

Messages to Printer: None

Element Name: CBNDRY

Element Type: FORTRAN LOGICAL FUNCTION

Entry Points: CBNDRY

Called By: PHASEA

External References: GETCON

Common Blocks: CONSTS

Calling Sequence: L, MODE

Variable	Description
L	Pointer to dictionary word.
MODE	= 1; Segment is a horizontal, regular cell segment. = 2; Segment is a regular cell vertical segment. = 3; Horizontal stress segment. = 4; Vertical stress segment

Element Description: CBNDRY tests for the existence of the segment type indicated by MODE. CBNDRY=.TRUE. if a segment of the type desired exists.

Abort Conditions: None

Messages to Printer: None

Element Name: CHOOSE

Element Type: FORTRAN INTEGER FUNCTION Subroutine

Entry Points: CHOOSE

Called By: BDNORM, BDSTRS

External References: None

Common Blocks: None

Calling Sequence: X, Y, I, J, XS, YS

Variable	Description
X,Y	Point coordinates.
I,J	Cell subscripts.
XS, YS	Sides of the cell.

Element Description: CHOOSE selects the cell sides nearest to the point (X,Y).

Abort Conditions: None

Messages to Printer: None

Element Name: CINOUT Element Type: FORTRAN Subroutine

Entry Points: CINOUT

Called By: MAIN 2

External References: RESTIN, RESTOU

Common Blocks: NONE

Calling Sequence: NONE

Processor: INTEG

Variable	Description

Element Description: CINOUT is a driver routine for the restart processor. It was originally inserted to force a particular allocation in the EXEC II version of STEEP 32.

Abort Conditions: None

Messages to Printer: None

Element Name: COLD Element Type: FORTRAN Subroutine

Entry Points: COLD

Called By: MAIN1, MAIN2, MAIN3

External References: SETSUB

Common Blocks: CONSTS, SHCOM, CUTBLK, DELSBK, SEGBLK, SUBSBK, CBLOCK, RCDATA

Calling Sequence: None

Processor: I.C., INTEG, EDIT

Variable	Description

Element Description: Subroutine COLD initializes several variables defining the grid and strain hardening points.

Abort Conditions: None

Messages to Printer: None

Element Name: COLPTS Element Type: FORTRAN Subroutine

Entry Points: COLPTS

Called By: PHASEA

External References: PACUNP, MASSIJ, ABORT, BDMOVE

Common Blocks: IOCNTL, RCDATA, BOUNDY, SUBSBK

Calling Sequence: None

Processor: INTEG

Variable	Description
ICOL	POINTER to column under consideration
IT	= 1 if ICOL is left-most column in problem = 2 if ICOL is an interior column = 3 if ICOL is right-most column in problem

Element Description: Subroutine COLPTS moves all the string points in a given column. If a point is found to lie within the given column and has not already been moved then COLPTS calls BDMOVE to move the point.

Abort Conditions: COLPTS - If a regular string point was found to have no cells around it with material.

Messages to Printer: None

Element Name: COMPUT Element Type: FORTRAN Subroutine

Entry Points: COMPUT

Called By: MAIN2

External References: SELDT, COMP1, MOVER, COMP2, STPOST

Common Blocks: CONSTS, SHCOM, FRSTBK, MATBLK

Calling Sequence: $, L

Processor: INTEG

Variable	Description
$	Nonstandard return which is taken when there is an interrupt in the normal flow of the integration computations.
L	Currently takes on the value 1.

Element Description: COMPUT is the driving routine for the math portion of the integration processor. It is described with the integration processor.

Abort Conditions: None

Messages to Printer: None

Element Name: COMP1 Element Type: FORTRAN Subroutine

Entry Points: COMP1

Called By: COMPUT

External References: SOPEN, PNTSET, SRITER, SREAD, PHASEA, HYPOEL, SCLOSE

Common Blocks: CONSTS

Calling Sequence: None

Processor: INTEG

Variable	Description

Element Description: COMP1 performs the first phase of the integration calculations. COMP1 makes one pass over the scratch drum file.

Abort Conditions: None

Messages to Printer: None

Element Name: COMP2 Element Type: FORTRAN Subroutine

Entry Points: COMP2

Called By: COMPUT

External References: SOPEN, SREAD, STRFLO, MASFLO, STRESS, SRITER, SCLOSE

Common Blocks: CONSTS

Calling Sequence: None

Processor: INTEG

Variable	Description

Element Description: Subroutine COMP2 performs the second phase of the math portion of the integration processor. COMP2 uses as inputs the scratch file created by COMP1 and in turn outputs an updated set of cell variables or drum.

Abort Conditions: None

Messages to Printer: None

Element Name: CONTLB

Element Type: FORTRAN Block Data Routine

Entry Points: NONE

Called By: ----

External References: None

Common Blocks: SCCNTL

Calling Sequence: None

Processor: EDIT

Variable	Description

Element Description: CONTLB initializes constants which are used only by the SC4020 processor. Since it is a BLOCK DATA routine it has no executable statements.

Abort Conditions: None

Messages to Printer: None

Element Name: CONTRL

Element Type: FORTRAN
Block Data Routine

Entry Points: None

Called By: ---

External References: None

Common Blocks: MATBLK, DELSBK, SCANBK, RCDATA, RCTEMP, SUBSBK, CONSTS, IOCNTL, TOLBLK

Calling Sequence: None

Processor: INTEG, EDIT

Variable	Description

Element Description: CONTRL is a BLOCK DATA program which initializes various items in the common blocks to their default values.

Abort Conditions: None

Messages to Printer: None

Element Name: CONTUR Element Type: FORTRAN Subroutine

Entry Points: CONTUR

Called By: FUNCT

External References: GETCON, ABORT, PLTBND, SOPEN, SREAD, SETSUB, VARIBL, BET

Common Blocks: SUBSBR, CONSTS, SEGBLK, RCDATA, SCCNTL, RCTEMP

Calling Sequence: Q

Processor: EDIT

Variable	Description
Q	The subscript to be used in the variables defining a particular plot.

Element Description: Subroutine CONTUR plots equal value contours of selected cell quantities on the SC4020. CONTUR makes one complete pass over the drum.

Abort Conditions:
CONT.1 If NCONT(Q) is not between 1 and NUMCON
CONT.2 If CONT YP(Q) is not between 1 and 7

Messages to Printer: None

Element Name: DATA Element Type: FORTRAN Subroutine

Entry Points: DATA

Called By: DUMSUB, MAIN3

External References: TITLE, SETSUB

Common Blocks: NETBLK, REGBLK, MATBLK, CONSTS, SHCOM, IOCNTL, PCNBLK, SUBSBK, RCDATA, BOUNDY

Calling Sequence: None

Processor: I.C., EDIT

Variable	Description

Element Description: DATA is used by the initial conditions and edit processors to read the namelist INITAL. DATA also initializes the region data to zero and reads in additional PCON constants if requested. For the edit processor DATA is used merely to define the I/O units.

Abort Conditions: None

Messages to Printer: DATA prints an abbreviated version to INITAL called INITLO. If additional PCON constants are read in, they too are listed.

Element Name: DIVU Element Type: FORTRAN Subroutine

Entry Points: DIVU

Called By: HYPOEL, VISCOS

External References: None

Common Blocks: DIVUBK, SUBSBK, CONSTS, RCDATA

Calling Sequence: IT, JT, U, V

Processor: INTEG

Variable	Description
IT	= 1 if left-most column = 2 if interior column = 3 if right-most column
JT	= 1 if bottom row = 2 interior row = 3 top row
U	Velocity component in X direction.
V	Velocity component in Y direction.

Element Description: Subroutine DIVU calculates the velocity gradients across a cell surface. The results are passed back to the calling routine via DIVUBK. The equations used in DIVU are 3.32 and 3.33 in Reference 1.

Abort Conditions: None

Messages to Printer: None

Element Name: DMSUB1 Element Type: FORTRAN Subroutine

Entry Points: DMSUB1

Called By: MAIN1

External References: REGION, OUTPUT

Common Blocks: GRDATA, CBLOCK, NETBLK, REGBLK, CONSTS, PCNBLK

Calling Sequence: None

Processor: I.C.

Variable	Description

Element Description: DMSUB1 is used by the initial conditions processor to call subroutines REGION and OUTPUT. DMSUB1 is then used in the MAP segment STARTR which isolates several subroutines and common blocks in the overlay structure.

Abort Conditions: None

Messages to Printer: None

Element Name: DOTPLT Element Type: FORTRAN Subroutine

Entry Points: DOTPLT

Called By: CONTUR

External References: None

Common Blocks: None

Calling Sequence: XI1, YI1, XI2, YI2, ID1, INCTR, KKK

Processor: EDIT

Variable	Description

Element Description: DOTPLT is called by CONTUR to draw dotted lines for the pressure contours.

Abort Conditions: None

Messages to Printer: None

Element Name: DUMSUB Element Type: FORTRAN Subroutine

Entry Points: DUMSUB

Called By: MAIN1

External References: DATA

Common Blocks: GRDATA, CBLOCK, NETBLK, REGBLK, CONSTS, PCNBLK

Calling Sequence: None

Processor: I.C.

Variable	Description

Element Description: DUMSUB is a dummy subroutine left from the EXECII version of STEEP. Its sole function is to call DATA.

Abort Conditions: None

Messages to Printer: None

Element Name: ENCLOS

Element Type: FORTRAN Logical Function

Entry Point: ENCLOS

Called By: BDNORM, BDSTRS

External References: BET

Common Blocks: None

Calling Sequence: (CX, CY, TX, TY, TI)

Processor: I.C., INTEG

Variable	Description
CX	X coordinate of cell center.
CY	Y coordinate of cell center.
TX	Array containing X coordinates of string points.
TY	Array containing Y coordinates of string points.
TI	The number of string points.

Element Description: ENCLOS determines if the point (CX, CY) lies inside of the material.

Abort Conditions: None

Messages to Printer: None

Element Name: EXIST Element Type: FORTRAN Subroutine

Entry Points: EXIST

Called By: PRNTIJ, BDMOVE, HYPOEL, SETDEL, SETFOR, STRESS, STRFLO, MASFLO, PLTSTR, VARIBL, VECTOR

External References: GETCON

Common Blocks: CONSTS

Calling Sequence: (L, M)

Processor: I.C., INTEG, EDIT

Variable	Description
L	Subscript of cell dictionary word.
M	= 1 Regular cell center at time N. = 2 Lattice point at time N. = 3 Lattice point at time N. = 4 Lattice point at time N-1. = 5 Lattice point at time N and N-1. = 6 Regular cell center at time N. = 7 Regular cell center at time N + 1.

Element Description: EXISTS calls subroutine GETCON to extract existence information for the points indicated by the value of M.

Abort Conditions: None

Messages to Printer: None

Element Name: EXTRAP

Element Type: FORTRAN Logical Function

Entry Points: EXTRAP

Called By: BDMOVE

External References: IBET

Common Blocks: CONSTS, SUBSBK

Calling Sequence: (IA, JA, M)

Processor: INTEG

Variable	Description
IA	I offset
JA	J offset
M	= 1 Regular cell = 2 Lattice cell

Element Description: EXTRAP determines the existence of the point (I+IA, J+JA) or (LI+IA, LJ+ JA) depending on the value of M.

Abort Conditions: None

Messages to Printer: None

Element Name: FCUT Element Type: FORTRAN Function Subroutine

Entry Points: FCUT

External References:

Common Blocks: None

Calling Sequence: A, B, C, D, Y, R

Processor: INTEG

Variable	Description
A	σ_{xx}
B	σ_{yy}
C	σ_{TT}
D	σ_{xy}
Y	Yield
R	$\sigma_{ij} \cdot \sigma_{ij}/2$

Element Description: FCUT is used in conjunction with the Perzyna model documented in Section 2.2 of Reference 2.

Abort Conditions: None

Messages to Printer: None

Element Name: FILE Element Type: FORTRAN Subroutine

Entry Points: FILE

Called By: RESTOU, RESTIN

External References: SETSUB, SRITER, SCLOSE, SOPEN, GETIME, GEDATE, SREAD, PRNTIJ

Common Blocks: CONSTS, MATBLK, SUBSBK, BOUNDY, PCNBLK, SHCOM, CBLOCK, GRDATA, RCDATA, CUTBLK, IOCNTL

Calling Sequence: $, $, MODE, MATCH

Processor: I.C., INTEG, EDIT

Variable	Description
$	Nonstandard return.
$	Nonstandard return.
MODE	= 1 Next restart file read from tape. = 2 Restart file is written. = 3 Skip to next file.
MATCH	FILE number to MATCH.

Element Description: Subroutine FILE reads or writes a selected restart file. The first nonstandard return is taken if an end of tape was encountered on a read. The second nonstandard return is taken when an illegal or unexpected record type is encountered.

Abort Conditions: None

Messages to Printer: After each record other than a cell variable record is read, FILE prints a message indicating the record type. Once the machine is completely refreshed FILE prints a message indicating this and identifying the logical unit, file number, and cycle number which is used.

Element Name: FILLER Element Type: FORTRAN Subroutine

Entry Points: FILLER

Called By: BDPOST

External References: GETCON, SETSUB, PUTCON

Common Blocks: SUBSBK, CONSTS

Calling Sequence: None

Processor: I.C., INTEG

Variable	Description

Element Description: FILLER completes entries in the cell dictionary after the boundary has been processed.

Abort Conditions: None

Messages to Printer: None

Element Name: FOLTES

Element Type: FORTRAN Logical Function

Entry Points: FOLTES

Called By: BONDPR

External References: LINES

Common Blocks: None

Calling Sequence: N, X, Y

Processor: I.C., INTEG

Variable	Description
N	The number of segments to be compared.
X	Array containing the X coordinates of segments.
Y	Array containing the Y coordinates of segments.

Element Description: FOLTES tests for a fold among inputted segments of strings. Each segment is tested against non-adjacent segments through subroutine LINES. If an intersection is found, LINES takes the alternate return and FOLTES is set to true.

Abort Conditions: None

Messages to Printer: None

Element Name: FORDIC Element Type: FORTRAN Subroutine

Entry Points: FORDIC

Called By: MOVER

External References: SETSUB, PUTCON

Common Blocks: CONSTS, SUBSBK

Calling Sequence: None

Processor: I.C., INTEG

Variable	Description

Element Description: Subroutine FORDIC loops over the entire grid to initialize each word of the cell dictionary.

Abort Conditions: None

Messages to Printer: None

Element Name: FUNCT Element Type: FORTRAN Subroutine

Entry Points: FUNCT

Called By: GRAPHS

External References: FXVSFY, VECTOR, ISOMET, MASSES, CONTUR, PLTSTR

Common Blocks: SCCNTL

Calling Sequence: (L)

Processor: EDIT

Variable	Description
L	Pointer to type of plot. L = 2 Velocity vectors L = 5 Contours L = 6 Principal stresses L = 7 Maximum shear Other values for L are not valid.

Element Description: Subroutine FUNCT selects the type of plot to be done on the SC4020.

Abort Conditions: None

Messages to Printer: None

Element Name: FXVSFY Element Type: FORTRAN Subroutine

Entry Points: FXVSFY

Called By: FUNCT

External References: ABORT

Common Blocks: None

Calling Sequence: None

Processor: EDIT

Variable	Description

Element Description: FXVSFY is a dummy routine. It was intended that FXVSFY eventually would become a routine which would perform parameter versus parameter plots.

Abort Conditions: None

Messages to Printer: None

Element Name: GEDATE Element Type: FORTRAN Subroutine

Entry Points: GEDATE

Called By: FILE

External References: None

Common Blocks: None

Calling Sequence: DATE

Processor: I.C., INTEG, EDIT

Variable	Description
DATE	Two words which when written in 2A6 format supply the current date.

Element Description: Now a dummy routine, GEDATE was originally a SLEUTH routine written for EXEC II.

Abort Conditions: None

Messages to Printer: None

Element Name: GENBND Element Type: FORTRAN Subroutine

Entry Points: GENBND

Called By: MAIN1

External References: ABORT, MASSIJ, PACUNP, PRTBPT

Common Blocks: SUBSBK, BOUNDY, CONSTS, CUTBLK, RCDATA, SHCOM, IOCNTL

Calling Sequence: None

Processor: None

Variable	Description

Element Description: GENBND reads the namelist BDSTRG to define new string points. Subroutine MASSIJ is called to determine the subscripts of the lattice and regular cells each string point is in. These subscripts are packed into the control word for the string point via subroutine PACUNP. Finally PRTBPT is called to print the string points.

Abort Conditions: GENNIM - The user indicated that strain hardening was to be performed but no strain hardening string points were specified.

GENBND - The strain hardening string points did not come first or there are no string points.

Messages to Printer: GENBND prints out the namelist BDSTRG. There is a message associated with the first GENBND abort. If a string point is found to lie outside the limits of the problem a message indicating this is printed along with the values of the relevant data.

Element Name: GETCON

Element Type: FORTRAN Integer Function Subroutine

Entry Points: GETCON

Called By: ARCEL, BDINIT, BDPOST, EXIST, FILLER, MAPMIX, PRNTCT, SETMAT, SETSEG, SETSID, STARVL. VOLCEL, CONTUR, LNEDIT, CBNDRY, SEGMNT, MASFLO

External References: SHFTR, TRACE, ABORT

Common Blocks: CONSTS, CBLOCK

Calling Sequence: L,M

Processor: I.C., EDIT

Variable	Description
L	Subscript of cell dictionary word desired.
M	Pointer to the type of cell information required.

Element Description: Subroutine GETCON extracts items from the cell dictionary word.

Abort Conditions: None

Messages to Printer: None

Element Name: GETIJ Element Type: FORTRAN Subroutine

Entry Points: GETIJ

Called By: ARECEL, VOLCEL, VARIBL

External References: None

Common Blocks: SUBSBK

Calling Sequence: L, K

Processor: I.C., INTEG, EDIT

Variable	Description
L	Subscript of the dictionary word to be used.
K	= 1 I, J are returned = 2 LI, IJ are returned

Element Description: Given the subscript for the dictionary word of a cell, GETIJ returns the row and column indices for the cell through the common block SUBSBK.

Abort Conditions: None

Messages to Printer: None

Element Name: GETIME Element Type: FORTRAN Subroutine

Entry Points: GETIME

Called By: FILE

External References: None

Common Blocks: None

Calling Sequence: HOUR

Processor: I.C., INTEG, EDIT

Variable	Description
HOUR	Two words which when written in 2A6 format supply the time of day.

Element Description: Now a dummy routine, GETIME was originally a SLEUTH routine written for EXEC II.

Abort Conditions: None

Messages to Printer: None

Element Name: GRAPHS Element Type: FORTRAN Subroutine

Entry Points: GRAPHS

Called By: PLOTTR

External References: PAPER, FUNCT

Common Blocks: IOCNTL, SCCNTL

Calling Sequence: None

Processor: EDIT

Variable	Description

Element Description: Subroutine GRAPHS processes all SC4020 graphs for a drum file. GRAPHS calls PAPER to create the background of the plot followed by FUNCT to provide the plot foreground.

Abort Conditions: None

Messages to Printer: None

Element Name: GRIDVT Element Type: FORTRAN Subroutine

Entry Points: GRIDVT

Called By: MAIN1, MAIN2, PLOTTR

External References: SETSUB, IBET, ABORT

Common Blocks: CONSTS, SUBSBK, RCDATA, NETBLK

Calling Sequence: None

Processor: I.C., INTEG, EDIT

Variable	Description

Element Description: Subroutine GRIDVT computes all the elements of the grid vector from the information in NETBLK.

Abort Conditions: None of the abort conditions currently provided for in GRIDVT can occur.

Messages to Printer: None

Element Name: HYPOEL Element Type: FORTRAN Subroutine

Entry Points: HYPOEL

Called By: COMP1

External References: EXIST, SETSUB, DIVU, VOLCEL

Common Blocks: CONSTS, MATBLK, DELSBK, IOCNTL, SEGBLK, SUBSBK, GRDATA, RCDATA, CUTBLK, DIVUBK

Calling Sequence: None

Processor: INTEG

Variable	Description

Element Description: Subroutine HYPOEL calculates the initial estimates of the deviatoric components of stress. The formulas used appear as equations 3.26 and 3.27 in Reference 1. The initial components of deviatoric stress are computed from the total components and an estimate of the pressure obtained from the trace of the σ_{ij} matrix at time N. If the stress cell does not exist both the estimated deviatoric components and the total stresses at time N are set to zero. This routine is not effective if both TWOMU and YIELD are zero.

Abort Conditions: None

Messages to Printer: None

Element Name: IBET

Element Type: FORTRAN Integer Function Subroutine

Entry Points: IBET

Called By: GRIDVT

External References: None

Common Blocks: None

Calling Sequence: A, X, B, M

Processor: I.C., EDIT

Variable	Description
A	Left point of interval.
B	Right point of interval.
X	Point under consideration.
M	Dummy variable.

Element Description: IBET determines if the integer X is between the the integers A and B.

IBET = -1 X < A or X > B

= 0 X > A and X < B

= 1 X = A

= 2 X = B

= 3 X = A = B

Abort Conditions: None

Messages to Printer: None

Element Name: INTPSH Element Type: FORTRAN Subroutine

Entry Points: INTPSH

Called By: MAIN1, BDINIT, MAIN2, MAIN3

External References: PUTGET

Common Blocks: BOUNDY

Calling Sequence: None

Processor: I.C., INTEG, EDIT

Variable	Description

Element Description: Subroutine INTPSH initializes the push down list. This releases the entire push down list for use by the boundary processor.

Abort Conditions: None

Messages to Printer: None

Element Name: INTRST Element Type: FORTRAN Subroutine

Entry Points: INTRST

Called By: BDNORM, BDSTRS

External References: LINES, ABORT

Common Blocks: None

Calling Sequence: X, Y, IX, JX, XT, YT, IN, JN, ISIDE, XS, YS

Processor: IC, INTEG

Variable	Description
X, Y	Coordinates of the string section to intersect.
IX, JX	Row and column indices for cell.
XT, YT	Coordinates of intersection .
IN, JN	I and J offsets for next cell.
ISIDE	Pointer to side of cell intersected.
XS, YS	Arrays containing cell sides.

Element Description: INTRST calculates the intersection of a segment of the string and the sides of a cell. Should there be more than one intersection, the last one found is returned.

Abort Conditions: INTRST - when no intersection is found.

Messages to Printer: None

Element Name: ISOMET

Element Type: FORTRAN Subroutine

Entry Points: ISOMET

Called By: FUNCT

External References: ABORT

Common Blocks: None

Calling Sequence: None

Processor: EDIT

Variable	Description

Element Description: ISOMET is a dummy routine. It provides a place to add isometric plotting capabilities should this be required.

Abort Conditions: ISOMET - if this subroutine is called.

Messages to Printer: None

Element Name: LEDPLT Element Type: FORTRAN Subroutine

Entry Points: LEDPLT

Called By: RESULT

External References: PAPER

Common Blocks: SCCNTL, IOCNTL, SCDEPS

Calling Sequence: None

Processor: EDIT

Variable	Description

Element Description: LEDPLT plots selected cell variables for the linear editor.

Abort Conditions: None

Messages to Printer: When LEDPLT produces a plot it prints the message "GRAPH" followed by the plot number.

Element Name: LINES Element Type: FORTRAN Subroutine

Entry Points: LINES

Called By: FOLTES, INTRST

External References: BET

Common Blocks: None

Calling Sequence: $, X1, Y1, X2, Y2, X, Y

Processor: I.C., INTEG

Variable	Description
$	Nonstandard return.
X1	X coordinate for first segment.
Y1	Y coordinate for first segment.
X2	X coordinate for second segment.
Y2	Y coordinate for second segment.
X	X coordinate of intersection
Y	Y coordinate of intersection

Element Description: LINES calculates the intersection between two line segments. If the two segments intersecting the coordinates of the intersection are returned. If they do not intersect the nonstandard return is taken.

Abort Conditions: None

Messages to Printer: None

Element Name: LINPLT Element Type: FORTRAN Subroutine

Entry Points: LINPLT

Called By: CONTUR, LEDPLT, PAPER, PAPER1, PLTBND, PLTSTR, VECTOR

External References: None

Common Blocks: None

Calling Sequence: XI1, YI1, XI2, YI2, ID1, INCTR

Processor: EDIT

Variable	Description
XI1, YI1	x, y coordinate of start of line.
XI2, YI2	x, y coordinate of end of line.
ID1	Pointer to edge of plot exceeded by first point.
INCTR	Pointer to edge of plot exceeded by second point.

Element Description: LINPLT draws lines for SC4020 plots. It first checks if either point is off the field of view. If so, the line is drawn up to edge of plot.

Abort conditions: None

Messages to Printer: None

Element Name: LNEDIT Element Type: FORTRAN Subroutine

Entry Points: LNEDIT

Called By: PLOTTR

External References: GETCON, SOPEN, SREAD, SETSUB, BET, RESULT

Common Blocks: SCCNTL, SUBSBK, CONSTS, RCDATA, SCDEPS, IOCNTL

Calling Sequence: PLOT

Processor: EDIT

Variable	Description
PLOT	The graph number

Element Description: LNEDIT was written for a specialized series of calculations involving the impact of a sphere on a thin plate. It extrapolates the current mass positions and velocities to calculate information about the scatter of material at a later time.

Abort Conditions: None

Messages to Printer: When a cell does not lie in the doner region selected or when the extrapolated values do not lie in the catacher region, diagnostic information is printed out.

Element Name: MAIN1 Element Type: FORTRAN Main Routine

Entry Points: None

Called By: None

External References: LOADRG, COLD, DUMSUB, INTPSH, GRIDVT, GENBND, MOVER, DMSUB1

Common Blocks: SIOBLK

Calling Sequence: None

Processor: I.C.

Variable	Description

Element Description: MAIN1 is the main routine for the initial conditions.

Abort Conditions: None

Messages to Printer: None

Element Name: MAIN2 Element Type: FORTRAN Main Routine

Entry Points: None

Called By: None

External References: COLD, CINOUT, GRIDVT, DATA2, INTPSH, COMPUT, PRNTCT, PRTBPT

Common Blocks: SIOBLK, CONSTS, FRSTBK

Calling Sequence: None

Processor: INTEG

Variable	Description

Element Description: MAIN2 is the main program for the integration processor.

Abort Conditions: None

Messages to Printer: None

Element Name: MAIN3 Element Type: FORTRAN Main Routine

Entry Points: None

Called By: None

External References: COLD, DATA, INTPSH, PLOTTR

Common Blocks: IOCNTL, CONSTS, SENSWT

Calling Sequence: None

Processor: EDIT

Variable	Description

Element Description: MAIN3 is the main routine for the edit processor.

Abort Conditions: None

Messages to Printer: None

Element Name: MAPMIX Element Type: FORTRAN Subroutine

Entry Points: MAPMIX

Called By: PRNTIJ

External References: GETCON, TITLE, SETSUB

Common Blocks: RCTEMP, CONSTS, SUBSBK, IOCNTL

Calling Sequence: None

Processor: I.C., INTEG, EDIT

Variable	Description

Element Description: Subroutine MAPMIX creates a display on the printer indicating if a cell is empty, cut, or full. Each print position represents a cell, a blank indicating a void, a 1 indicating a partially full cell and a 2 indicating a completely full cell.

Abort Conditions: None

Messages to Printer: As Indicated

Element Name: MASFLO Element Type: FORTRAN Subroutine

Entry Points: MASFLO

Called By: COMP2

External References: GETCON, EXIST, SETSUB, SEGMNT, VOLCEL

Common Blocks: CONSTS, DELSBK, IOCNTL, SEGBLK, SUBSBK, CBLOCK, GRDATA, RCDATA, CUTBLK, RCTEMP

Calling Sequence: IMASFL

Processor: INTEG

Variable	Description
IMASFL	Column currently being computed.

Element Description: Subroutine MASFLO calculates the flow terms for mass, momentum and energy. MASFLO then repartitions the completed cells. The mathematics used in MASFLO can be derived from the equations appearing in Section 3.2.2.1 of Reference 1.

Abort Conditions: None

Messages to Printer: MASFLO prints out cycle by cycle totals of mass, momentum, and energy. If during a calculation negative energy was set to zero, the total amount of negative energy for the cycle is printed following the message "TOTAL NEGATIVE ENERGY SUPPRESSED".

Element Name: MASSES Element Type: FORTRAN Subroutine

Entry Points: MASSES

Called By: FUNCT

External References: ABORT

Common Blocks: None

Calling Sequence: None

Processor: EDIT

Variable	Description

Element Description: MASSES is currently a dummy subroutine. It was intended that additional plotting capabilities would be inserted here eventually.

Abort Conditions: MASSES - if subroutine is called.

Messages to Printer: None

Element Name: MASSIJ Element Type: FORTRAN Subroutine

Entry Points: MASSIJ

Called By: GENBND, BDMOVE, COLPTS

External References: SETSUB

Common Blocks: SUBSBK, CONSTS, RCDATA

Calling Sequence: $, K, XM, YM

Processor: I.C., INTEG

Variable	Description
$	Nonstandard return.
K	= 0 All four subscripts are obtained.
	= 1 Only I and J are obtained.
	= 2 Only LI and LJ are obtained.
XM	X coordinate of string point.
YM	Y coordinate of string point.

Element Description: Subroutine MASSIJ determines the subscripts of the regular and lattice cell from the mass portion for a particular string point.

Abort Conditions: None

Messages to Printer: None

Element Name: MOVER Element Type: FORTRAN Subroutine

Entry Points: MOVER

Called By: MAIN1, COMPUT

External References: BDINIT, BONDPR, FORDIC, BDPOST

Common Blocks: BOUNDY

Calling Sequence: None

Processor: I.C., INTEG

Variable	Description

Element Description: Subroutine MOVER processes the boundary string after the string points have been moved. It is the driver routine for the string processor used merely to call BDINIT, BONDPR, FORDIC and BDPOST.

Abort Conditions: None

Messages to Printer: None

Element Name: OUTPUT Element Type: FORTRAN Subroutine

Entry Points: OUTPUT

Called By: DMSUB1

External References: PRNTCT, PRTBPT, RESTOU

Common Blocks: None

Calling Sequence: None

Processor: I.C.

Variable	Description

Element Description: Subroutine OUTPUT is used by initial conditions to produce printed output of the control dictionary, string positions, and the cell variables. It also writes the initial conditions restart.

Abort Conditions: None

Messages to Printer: None

Element Name: PACKER Element Type: FORTRAN Subroutine

Entry Points: PACUNP

Called By: BONDPR, GENBND, PRTBPT, COLPTS

External References: SHIFTL, SHIFTR

Common Blocks: None

Calling Sequence: T, S, MODE

Processor: I.C., INTEG

Variable	Description
MODE	= 1; Packing items in array"s" into word "T". = 2; Unpacking items from word "T" into array"s".

Element Description: Subroutine PACKER packs and unpacks the subscripts from the dictionary word for the string points.

Abort Conditions: None

Messages to Printer: None

Element Name: PAPER Element Type: FORTRAN Subroutine

Entry Points: PAPER

Called By: GRAPHS, LEDPLT

External References: None

Common Blocks: SCDEPS, CONSTS, SCCNTL

Calling Sequence: I

Processor: EDIT

Variable	Description
I	Number of the plot frame to be drawn.

Element Description: Subroutine PAPER draws the background for an SC4020 plot. PAPER first advances the frame. It then provides the standard titles, labels, and grid. If the plot is a contour plot, additional labeling is provided to distinguish the different contours. If the plot is a velocity or stress field, a characteristic vector length is plotted.

Abort Conditions: None

Messages to Printer: None

Element Name: PHASEA Element Type: FORTRAN Subroutine

Entry Points: PHASEA

Called By: COMP1

External References: CBNDRY, SETSUB, VOLCEL, SETFOR, COLPTS

Common Blocks: CONSTS, DELSBK, IOCNTL, SEGBLK, SUBSBK, CBLOCK, GRDATA, RCDATA, CUTBLK, RCTEMP, TOLBLK

Calling Sequence: IPHSA

Processor: INTEG

Variable	Description
IPHSA	Index to column being computed.

Element Description: Subroutine PHASEA is called during the initial part of the integration computations to calculate the energy and velocity estimates. PHASEA calls SETFOR to determine the forces on the sides of the cell. The equations for calculating the estimated velocities and energies appear as equations 3.20, 3.21, and 3.25 in Reference 1. Incidental to these calculations PHASEA calls COLPTS to move the string points in a column.

Abort Conditions: None

Messages to Printer: None

Element Name: PHI

Element Type: FORTRAN Real Function Subroutine

Entry Points: PHI

Called By: PLASFL

External References: None

Common Blocks: None

Calling Sequence: None

Processor: INTEG

Variable	Description

Element Description: Subroutine PHI is a special function used in conjunction with the Perzyna model. A description of the Perzyna model can be found in Section 2.2 of Reference 2.

Abort Conditions: None

Messages to Printer: None

Element Name: PLASFL Element Type: FORTRAN Subroutine

Entry Points: PLASFL

Called By: VISCOS

External References: ABORT, YLD, FCUT, THETA, PHI

Common Blocks: MATBLK, CONSTS, RCDATA, TOLBLK, BOUNDY, SHCOM, CUTBLK, SUBSBK, DIVUBK

Calling Sequence: SXX, SYY, STT, TXY

Processor: INTEG

Variable	Description
SXX SYY STT TXY	The deviatoric stresses.

Element Description: Subroutine PLASFL imposes the yield conditions upon the deviatoric stresses and calculates the incremental change in the strain rate. Currently either the von Mises or Perzyna models may be selected.

Abort Conditions: PLASFL if there are more than 50 string points in a particular stress cell.

Messages to Printer: If the Perzyna model is selected there are three messages which may be printed in conjunction with the Newtons' method. These messages start off

"XN TOO LARGE"

"NEWTONS METHOD FAILS TO CONVERGE"

"F FROM NEWTON IS TOO LARGE"

Element Name: PLOTTR Element Type: FORTRAN Subroutine

Entry Points: PLOTTR

Called By: MAIN3

External References: ABORT, FILE, GRIDVT, LNEDIT, GRAPHS

Common Blocks: IOCNTL, SCCNTL, SCDEPS

Calling Sequence: None

Processor: EDIT

Variable	Description

Element Description: Subroutine PLOTTR is one of the main routines in the in the SC4020 processor. PLOTTR reads the data which controls both the plots and the restarting. Subroutine GRAPHS is called to actually produce the plots.

Abort Conditions:

PLTR.1 - if the number of files to edit is zero and DOALL = .FALSE.

PLTR.2 - NGRAPH .LE.0

Messages to Printer: PLOTTR lists the input data.

Element Name: PLTBND Element Type: FORTRAN Subroutine

Entry Points: PLTBND

Called By: CONTUR, PLTSTR, VECTOR

External References:

Common Blocks: BOUNDY, SCCNTL

Calling Sequence: M

Processor: EDIT

Variable	Description
M	Type of graph being plotted.

Element Description: Subroutine PLTBND plots string points. The points which are associated with real strings are connected with straight lines.

Abort Conditions: None

Messages to Printer: None

Element Name: PLTSTR Element Type: FORTRAN Subroutine

Entry Points: PLTSTR

Called By: FUNCT

External References: EXIST, SOPEN, SREAD, SETSUB

Common Blocks: CONSTS, SUBSBK, RCDATA, GRDATA, SCCNTL

Calling Sequence: L, MM

Processor: EDIT

Variable	Description
L	Graph Number
MM	= 1; Principal stresses are plotted. = 2; Maximum shear stresses are plotted.

Element Description: PLTSTR plots either the principal stresses or the maximum shear. PLTSTR makes one pass over the drum file.

Abort Conditions: None

Messages to Printer: None

Element Name: PNTSET Element Type: FORTRAN Subroutine

Entry Points: PNTSET

Called By: COMP1

External References: PACUNP

Common Blocks: BOUNDY

Calling Sequence: None

Processor: INTEG

Variable	Description

Element Description: PNTSET sets each string control word to indicate that the string point has not been moved.

Abort Conditions: None

Messages to Printer: None

Element Name: PRESS Element Type: FORTRAN Subroutine

Entry Points: PRESS

Called By: STRESS

External References: TBFTO2

Common Blocks: PCNBLK, EOSBLK, MATBLK

Calling Sequence: IS

Processor: I.C., INTEG

Variable	Description
IS	Material number being considered.

Element Description: Subroutine PRESS is called by subroutine STRESS to determine the pressure at a lattice point. Currently it assumes that the equation of state TBFTO2 is being used. The density and specific internal energy are inputted through the common block EOSBLK as variables labeled ETA and EN respectively. The pressure and sound speed squared are in turn outputted in EOSBLK as the variables PRES and VL.

Abort Conditions: None

Messages to Printer: None

Element Name: PRESTI Element Type: FORTRAN Subroutine

Entry Points: PRESTI

Called By: COMPUT

External References: None

Common Blocks: None

Calling Sequence: None

Processor: INTEG

Variable	Description

Element Description: PRESTI supplies externally applied pressure to subroutine COMPUT. PRESTI currently has no pressure function.

Abort Conditions: None

Messages to Printer: None

Element Name: PRNTCT Element Type: FORTRAN Subroutine

Entry Points: PRNTCT

Called By: OUTPUT, MAIN2

External References: GETCON, SETSUB, TITLE

Common Blocks: CONSTS, IOCNTL, SUBSBK, CBLOCK

Calling Sequence: None

Processor: I.C., INTEG

Variable	Description

Element Description: Subroutine PRNTCT prints the contents of the cell dictionary. Lines that are equal by columns are not printed.

Abort Conditions: None

Messages to Printer: None

Element Name: PRNTIJ Element Type: FORTRAN Subroutine

Entry Points: PRNTIJ

Called By: FILE

External References: EXIST, SETSUB, TITLE, ARECEL, VOLCEL, MAPMIX

Common Blocks: CONSTS, DELSBK, IOCNTL, SUBSBK, SEGBLK, CBLOCK, GRDATA, CUTBLK, RCDATA, RCTEMP

Calling Sequence: IPRT

Processor: I.C., INTEG, EDIT

Variable	Description
IPRT	Current column number being printed.

Element Description: Subroutine PRNTIJ prints the values of regular cell variables for a given column. This is followed by the values of the stress cell variables for that column. PRNTIJ is used as a subroutine to RESTOU to avoid making multiple passes over the drum. PRNTIJ also totals the momentums, kinetic energy, internal energy, and the total energy. These totals are printed out following the stress cell variables for the last column.

For the integration or COMPUT processor PRNTIJ, checks on activities before printing. A regular cell is considered active if either component of velocities or the internal energy for that cell is non-zero. A stress cell is considered active if any one of the σ_{ij} are non-zero.

Abort Conditions: None

Messages to Printer: As indicated.

Element Name: PRTBPT Element Type: FORTRAN Subroutine

Entry Points: PRTBPT

Called By: GENBND, OUTPUT, MAIN2

External References: TITLE, PACUNP

Common Blocks: IOCNTL, BOUNDY, SHCOM, CUTBLK

Calling Sequence: None

Processor: I.C., INTEG

Variable	Description

Element Description: PRTBPT prints the positions of all the string points.

Abort Conditions: None

Messages to Printer: As indicated.

Element Name: PUTCON Element Type: FORTRAN Subroutine

Entry Points: PUTCON

Called By: BDINIT, FILLER, FORDIC, SETMAT, SETSEG, SETSID, STARVL

External References: SHFTL

Common Blocks: CONSTS, CBLOCK

Calling Sequence: A, L, M

Processor: I.C., INTEG

Variable	Description
A	The data item to enter into the dictionary.
L	Location of the dictionary word.
M	= 0; Entire word "A" is set into the dictionary. ≠ 0; Then M is the key for the item to be placed in the dictionary.

Element Description: PUTCON puts control information for a regular cell or lattice cell into the cell dictionary. PUTCON is the counter part to GETCON.

Abort Conditions: None

Messages to Printer: None

Element Name: PUTGET Element Type: FORTRAN Subroutine

Entry Points: PUTGET

Called By: BDINIT, INTPSH, SETSEG, STARVL

External References: ABORT

Common Blocks: CUTBLK, BOUNDY

Calling Sequence: LOC, MODE

Processor: I.C., INTEG

Variable	Description
MODE	= 1; "LOC" is obtained and set by this routine. = 2; "LOC" is released and next available location is set to the value of "LOC".

Element Description: PUTGET manipulates the pushdown list in CUTBLK.

Abort Conditions:

GET - There is an attempt to get a location in the pushdown lists and then are no more available.

PUT - There is an attempt to release a location whose value is 0 or greater than the number of available locations.

Messages to Printer: None

Element Name: REGION Element Type: FORTRAN Subroutine

Entry Points: REGION

Called By: DMSUB1

External References: SOPEN, SREAD, SETSUB, VOLCEL, SRITER, SCLOSE

Common Blocks: CONSTS, SUBSBK, IOCNTL, GRDATA, RCDATA, REGBLK, MATBLK, EOSBLK

Calling Sequence: MODE

Processor: I.C.

Variable	Description
MODE	Dummy and argument.

Element Description: REGION sets the initial values of the cell variables. REGION leaves the machine refreshed with a new file on drum.

Abort Conditions: None

Messages to Printer: None

Element Name: RESTIN Element Type: FORTRAN Subroutine

Entry Points: RESTIN

Called By: CINOUT

External References: FILE

Common Blocks: IOCNTL

Calling Sequence: None

Processor: INTEG

Variable	Description

Element Description: RESTIN controls the refreshing process from the restart tape. As its input RESTIN reads the namelist RSTART. Subroutine FILE is called both to position the tape and to read the desired file.

Abort Conditions: None

Messages to Printer: The namelist RSTART is printed. In addition information identifying the files being read by subroutine FILE is provided.

Element Name: RESTOU Element Type: FORTRAN Subroutine

Entry Points: RESTOU

Called By: OUTPUT, CINOUT

External References: FILE

Common Blocks: IOCNTL

Calling Sequence: None

Processor: I.C., INTEG

Variable	Description

Element Description: RESTOU writes a restart file on the output tape.

Abort Conditions: None

Messages to Printer: None

Element Name: RESULT Element Type: FORTRAN Subroutine

Entry Points: RESULT

Called By: LNEDIT

External References: LEDPLT

Common Blocks: CONSTS, SCCNTL, GRDATA, RCDATA, SCDEPS, IOCNTL

Calling Sequence: IGOTO, PLOT

Processor: EDIT

Variable	Description
IGOTO	= 1; Additional printout is taken = 2; Only key printout is taken
PLOT	= .TRUE.; Subroutine LEDPLT, forcing plotting of linear editor.

Element Description: Result is the control routine for print and plot in the linear editor.

Abort Conditions: None

Messages to Printer: RESULT prints out the results of the linear extrapolation. This is the mass, momenta, and energies in each of the catcher regions.

Element Name: SAVSUB Element Type: FORTRAN Subroutine

Entry Points: SAVSUB

Called By: ARECEL, VOLCEL, VARIBL

External References: None

Common Blocks: SUBSBK

Calling Sequence: MODE

Processor: I.C., INTEG, EDIT

Variable	Description
MODE	= 1; Items in SUBSBK are stored in local storage OU. = 2; Items in SUBSBK are restored in local storage IN.

Element Description: SAVSUB saves and restores subscript information in common block SUBSBK.

Abort Conditions: None

Messages to Printer: None

Element Name: SEGMNT Element Type: FORTRAN Subroutine

Entry Points: SEGMNT

Called By: MASFLO, SETDEL, SETFOR

External References: GETCON

Common Blocks: CONSTS, IOCNTL, SEGBLK, SUBSBK, RCDATA, CUTBLK

Calling Sequence: (L, M)

Processor: INTEG

Variable	Description
L	= 1; Horizontal segment. = 2; Vertical segment.
M	= 1; Regular cell. = 2; Lattice cell.

Element Description: Subroutine SEGMNT determines the type of segment and the end points of the segments for either the vertical or horizontal side of a stress or regular cell. The output from this routine appears in common block SEGBLK. The output from SEGMNT is as follows:

NOSEG - The numbers of segments containing mass.

NOCUT - The number of times a cell is cut.

XA - X coordinates of the cuts.

XB - Y coordinates of the cuts.

Abort Conditions: None

Messages to Printer: None

Element Name: SELDT Element Type: FORTRAN Subroutine

Entry Points: SELDT

Called By: COMPUT

External References: BET, ABORT

Common Blocks: CONSTS, IOCNTL

Calling Sequence: None

Processor: INTEG

Variable	Description

Element Description: SELDT monitors the stability conditions for a STEEP solution and adjusts the integration time step DT to hold the solution stable. The inputs to SELDT are CMAX and VMAX. CMAC is calculated by subroutine STRESS. VMAX is calculated by subroutine MASFLO. The quantity SMAX is set to the maximum of CMAX and VMAX. DT is then decreased if SMAX is greater than S1 or increased if it is less than S2. The following formulas define CMAX and VMAX:

$$CMAX = \left[\frac{(\text{Particle Velocity} + \text{Dilatational Wave Speed}) * \Delta t}{\Delta X \cdot \Delta Y} \right]^2$$

$$VMAX = \left[\frac{\text{Maximum Particle Velocity} * \Delta t}{\frac{1}{2}\text{Minimum } (\Delta X, \Delta Y)} \right]^2$$

Abort Conditions: None

Messages to Printer: None

Element Name: SETDEL Element Type: FORTRAN Subroutine

Entry Points: SETDEL

Called By: STRFLO

External References: EXIST, SETSUB, SEGMNT

Common Blocks: CONSTS, DELSBK, IOCNTL, SUBSBK, SEGBLK, CBLOCK, GRDATA, RCDATA, RCTEMP, CUTBLK

Calling Sequence: II, JJ, MODE

Processor: INTEG

Variable	Description
II	Column pointer for lattice cell.
JJ	Row pointer for lattice cell.
MODE	= 1; Stress flow across horizontal surface being calculated. = 2; Stress flow across vertical surface being calculated. = 3; Stress flow across both surfaces being calculated.

Element Description: SETDEL computes the stress flow across the selected surfaces of a lattice cell. The actual flow for each of the components is returned through common block DELSBK.

Abort Conditions: None

Messages to Printer: None

Element Name: SETFOR Element Type: FORTRAN Subroutine

Entry Points: SETFOR

Called By: PHASEA

External References: EXIST, SURPRE, SETSUB, SEGMNT, BOUNST, ARECEL

Common Blocks: CONSTS, DELSBK, IOCNTL, SUBSBK, SEGBLK, GRDATA, CUTBLK, RCDATA, RCTEMP

Calling Sequence: II, JJ, MODE

Processor: INTEG

Variable	Description
II	Column pointer for regular cell.
JJ	Row pointer for regular cell.
MODE	= 1; Forces for horizontal surface are set. = 2; Forces for vertical surface are set. = 3; Forces for both surfaces and force into plane are set.

Element Description: SETFOR sets the horizontal and vertical forces on the surfaces of a regular cell. The final forces are returned through RCTEMP.

Abort Conditions: None

Messages to Printer: None

Element Name: SETMAT Element Type: FORTRAN Subroutine

Entry Points: SETMAT

Called By: BDPOST

External References: GETCON, SETSUB, ABORT, PUTCON

Common Blocks: CONSTS, SUBSBK, CUTBLK

Calling Sequence: None

Processor: I.C., INTEG

Variable	Description

Element Description: SETMAT is used during the boundary processing to set the cell dictionary word.

Abort Conditions: SETMAT - If a negative value was extracted from the cell dictionary.

Messages to Printer: None

Element Name: SETSEG Element Type: FORTRAN Subroutine

Entry Points: SETSEG

Called By: BDNORM, BDSTRS

External References: GETCON, SETSUB, PUTGET, PUTCON, ABORT

Common Blocks: CONSTS, SUBSBK, CUTBLK

Calling Sequence: IFLG, I, J, X, Y, SIDE, M

Processor: I.C., INTEG

Variable	Description
I, J	Column and row indices of cell under consideration.
X, Y	Intersection points.
SIDE	Side which is cut.
M	= 1; Regular cell, = 2; Stress cell.
IFLG	Not used.

Element Description: SETSEG allocates space for a cut cell and stores information in CUTBLK.

Abort Conditions: SETSG2 - If a boundary point lies on a cell side.

Messages to Printer: SETSEG prints three types of diagnostic messages. The first indicates that a string point was found to lie on a cell side. The other two indicate that a LOC was or was not released.

Element Name: SETSID Element Type: FORTRAN Subroutine

Entry Points: SETSID

Called By: BDPOST

External References: GETCON, ABORT, PUTCON

Common Blocks: SCANBK

Calling Sequence: None

Processor: I.C., INTEG

Variable	Description

Element Description: SETSID scans over the segment types previously set in the cell dictionary and fills in particular key items. SETSID sweeps over the dictionary line by line in the direction specified by the calling routine through common block SCANBK.

Abort Conditions: SETSID - Either an initial key was found to be negative or an illegal key was found.

Messages to Printer: None

Element Name: SETSUB Element Type: FORTRAN Subroutine

Entry Points: SETSUB

Called By: BDNORM, BDPOST, BDSTRS, COLD, DATA, FILE, FILLER, FORDIC, GRIDVT, MAPMIX, MASSIJ, PRNTIJ, PRNTCT, REGION, SETMAT, SETSEG, STARVL, BDMOVE, HYPOEL, PHASEA, SETDEL, SETFOR, STRESS, STRFLO, MASFLO, CONTUR, LNEDIT, PLTSTR, VARIBL, VECTOR

External References: ABORT

Common Blocks: CONSTS, SUBSBK

Calling Sequence: K

Processor: I.C., INTEG, EDIT

Variable	Description
K	= 0; Initialize offset values for problem. = 1; Cell reference IJ and dictionary reference IJD are set from cell indices I and J. = 2; Lattice cell information is from LI and LJ. = 3; Lattice cell information is from I and J. = 4; Cell and lattice cell information is from I and J. = 5; Cell and lattice cell information is from LI and LJ. = 6; I and J are set from LI and LJ. = 7; Regular cell information is set from LI and LJ.

Ellement Description: Subroutine SETSUB serves two functions. First for K = 0 it initializes the quantities which allow the programmer to refer to offset cells in GRDATA and in the cell dictionary. For the other values of K items are set in common block SUBSBK. SETSUB and SIO are the only two routines which have direct information about the rotation of the buffers in GRDATA.

Abort Conditions: SETSUB - If the column or row index causes a violation of the code dimensions.

Messages to Printer: None

Element Name: SETUP Element Type: FORTRAN Subroutine

Entry Points: SETUP

Called By: STARVL

External References: None

Common Blocks: CUTBLK

Calling Sequence: L

Processor: I.C., INTEG

Variable	Description
L	Superscript for variables in CUTBLK.

Element Description: SETUP initializes values in common block CUTBLK subscripted by L.

Abort Conditions: None

Messages to Printer: None

Element Name: SHFTL

Element Type: FORTRAN Integer Function Subroutine

Entry Points: SHFTL

Called By: PUTCON

External References: None

Common Blocks: None

Calling Sequence: IWORD, NBITS

Processor: I.C.

Variable	Description
IWORD	Word to be shifted.
NBITS	Number of bits to be shifted.

Element Description: SHFTL currently outputs the contents of IWORD, shifted left NBITS, by multiplying by powers of two. Since this is inefficient, SHFTL should be replaced by a SLEUTH routine or the references to it should be changed to use an appropriate system routine if one is available.

Abort Conditions: None

Messages to Printer: None

Element Name: SHFTR

Element Type: FORTRAN Integer Function Subroutine

Entry Points: SHFTR

Called By: GETCON, PACKER

External References: None

Common Blocks: None

Calling Sequence: IWORD, NBITS

Processor: *I.C., INTEG, EDIT*

Variable	Description
IWORD	Word being shifted.
NBITS	Number of bits to shift.

Element Description: SHFTR shifts right. Analogous to SHFTL.

Abort Conditions: None

Messages to Printer: None

Element Name: SHIFTL

Element Type: FORTRAN Integer Function Subroutine

Entry Points: SHIFTL

Called By: PACKER

External References: None

Common Blocks: None

Calling Sequence: IWORD, NBITS

Processor: I.C., INTEG

Variable	Description
IWORD	Word to be shifted.
NBITS	Number of bits to shift.

Element Description: Same as SHFTL

Abort Conditions: None

Messages to Printer: None

Element Name: SHIFTR

Element Type: FORTRAN Integer Function Subroutine

Entry Points: SHIFTR

Called By: PACKER

External References: None

Common Blocks: None

Calling Sequence: IWORD, NBITS

Processor: I.C., INTEG

Variable	Description
IWORD	Word to be shifted.
NBITS	Number of bits to shift.

Element Description: Same as SHFTR.

Abort Conditions: None

Messages to Printer: None

Element Name: SIO Element Type: FORTRAN Subroutine

Entry Points: SOPEN, SREAD, SRITER, SCLOSE

Called By: FILE, REGION, CONTUR, LNEDIT, PLTSTR, VECTOR, COMP1, COMP2

External References: ABORT, NTRAN

Common Blocks: GRDATA, IOCNTL, CONSTS, SIOBLK

Calling Sequence: None

Processor: I.C., EDIT, INTEG

Variable	Description

Element Description: Subroutine SIO controls the reading and writing of the scratch drum files. To open a scratch file and initialize reading a call to SOPEN must be made. A call to SREAD insures that the previously initiated read is completed and issues a new read. A call to SWRITE waits for completion of the previous write and then initiates the next write. A call to CLOSE forces out all waiting writes, writes an end of file, and swaps the input and output units.

Abort Conditions:

NOFILE An attempt was made to open a file which was never created.

EROPEN An attempt was made to read a file which was not opened.

IOERR A read or write transmission error occurred.

Messages to Printer: None

Element Name: STARVL Element Type: FORTRAN Subroutine

Entry Points: STARVL

Called By: BDNORM, BDSTRS

External References: GETCON, SETSUB, PUTGET, PUTCON, SETUP

Common Blocks: CONSTS, SUBSBK, CUTBLK

Calling Sequence: I, J, A, V, MATL, M

Processor: I.C., INTEG

Variable	Description
M	= 1; For regular cells. = 2; For lattice cells.
I,J	Subscripts to the cell in question.
A, V	Incremental area and volume
MATL	= .TRUE., Point LPT is set for lattice cells.

Element Description: STARVL stores the area and volume for a cut cell. If the cell had a previous area and volume A and V are added in. Either CMAT or LMAT is set to 1 to indicate the cell is cut.

Abort Conditions: None

Messages to Printer: None

Element Name: STPOST Element Type: FORTRAN Subroutine

Entry Points: STPOST

Called By: COMPUT

External References: None

Common Blocks: SHCOM, CUTBLK

Calling Sequence: None

Processor: INTEG

Variable	Description

Element Description: STPOST updates the strain hardening at the string points which carry strain hardening. The change in strain hardening is set to zero in preparation for the next cycle.

Abort Conditions: None

Messages to Printer: None

Element Name: STRESS Element Type: FORTRAN Subroutine

Entry Points: STRESS

Called By: COMP2

External References: EXIST, SETSUB, SURPRE, VOLCEL, ABORT, PRESS, VISCOS

Common Blocks: DELSBK, DIVUBK, EOSBLK, MATBLK, CONSTS, IOCNTL, SUBSBK, SEGBLK, CBLOCK, GRDATA, DSTARS, RCDATA, SHCOM, BOUNDY, TOLBLK

Calling Sequence: ISTRS

Processor: INTEG

Variable	Description
ISTRS	Denotes which column is to be processed.

Element Description: Subroutine STRESS is called to calculate the final stress. It is the last major routine in the integration process. The inputs to STRESS are the deviatoric components of stress for the column ISTRS. An effective energy and density are calculated from the four surrounding regular cells. The effective energy is calculated using mass weighting. The effective density is calculated as the sum of the masses of the surrounding regular cells divided by the sum of their volumes. The equation of state is then used to produce the pressure and sound speed of the material. VISCOS is called next to impose the yield condition and to calculate the artificial viscosities. The resulting pressure and viscosity are added to the constrained deviators to produce the final stresses.

Abort Conditions:

STRES2 A lattice point exists but none of the surrounding regular cells have mass.

STRES3 A lattice point exists but none of the surrounding regular cells have volume.

Messages to Printer: PRESSURE TOO LARGE followed by identifying information indicates $P \geq PMAX$.

MASS SUPPRESSED followed by identifying information indicates the effective densities is greater than an inputted maximum supplied by user.

Element Name: STRESS

Messages to Printer: Continued

PARTVL TOO LARGE followed by the value of the particle velocity indicates that the cell particle velocity was greater than the value of TOLNEW(3) supplied by the user. This cell will not be allowed to enter into the stability calculations.

Following the calculations for the last column in the problem, the peak values, stresses, and pressure are printed for each cycle.

Element Name: STRFLO Element Type: FORTRAN Subroutine

Entry Points: STRFLO

Called By: COMP2

External References: EXIST, SETSUB, SETDEL, VOLCEL

Common Blocks: CONSTS, DELSBK, IOCNTL, SUBSBK, SEGBLK, CBLOCK, GRDATA, RCDATA, CUTBLK, RCTEMP, MATBLK

Calling Sequence: ISTRFL

Processor: INTEG

Variable	Description
ISTRFL	Index of column to compute.

Element Description: STRFLO is one of the major subroutines in the second part of the integration processor. STRFLO completes the flow terms in the deviatoric stress components for a given column and thus determines the final deviatoric components of stress. STRFLO is not executed for a purely hydrodynamic solution.

Abort Conditions: None

Messages to Printer: None

Element Name: SURPRE

Element Type: FORTRAN Real Function Subroutine

Entry Points: SURPRE

Called By: SETFOR, STRESS

External References: None

Common Blocks: None

Calling Sequence: (I, J)

Processor: INTEG

Variable	Description
I	Column pointer.
J	Row pointer.

Element Description: SURPRE supplies surface pressure when required.

Abort Conditions: None

Messages to Printer: None

Element Name: TBFTO2 Element Type: FORTRAN Subroutine

Entry Points: TBFTO2

Called By: PRESS

External References: BET

Common Blocks: EOSBLK, PCNBLK

Calling Sequence: None

Processor: I.C., INTEG

Variable	Description

Element Description: TBFTO2 is a tabular equation of state for aluminum.

Abort Conditions: None

Messages to Printer: None

Element Name: THETA

Element Type: FORTRAN Real Function Subroutine

Entry Points: THETA

Called By: PLASFL

External References: None

Common Blocks: None

Calling Sequence: EP

Processor: INTEG

Variable	Description
EP	Plastic strain, ϵ_p.

Element Description: THETA is a specialized function used in conjunction with the Perzyna work hardening model.

Abort Conditions: None

Messages to Printer: None

Element Name: TITLE Element Type: FORTRAN Subroutine

Entry Points: TITLE

Called By: DATA, MAPMIX, PRNTIJ, PRNTCT, PRTBPT, DATAL

External References: IOCNTL, CONSTS

Common Blocks: None

Calling Sequence: None

Processor: I.C., INTEG

Variable	Description

Element Description: TITLE writes a standardized title for the print file.

Abort Conditions: None

Messages to Printer: None

Element Name: VARIBL

Element Type: FORTRAN Real Function Subroutine

Entry Points: VARIBL

Called By: CONTUR

External References: EXIST, VOLCEL, SAVSUB, GETIJ, SETSUB

Common Blocks: SUBSBK, CONSTS, GRDATA

Calling Sequence: IJ, TYPE

Processor: EDIT

Variable	Description
IJ	Is a subscript either to the GRDATA buffer or to the cell dictionary depending on the value for type.
TYPE	= 1; Specific internal energy. = 2; Density. = 3; Dynamic pressure. = 4; Kinetic energy. = 5; U momentum. = 6; V momentum. = 7; P at center of mass.

Element Description: The function VARIBL returns the value of a regular cell variable to be used in the contour plots.

Abort Conditions: None

Messages to Printer: None

Element Name: VECTOR Element Type: FORTRAN Subroutine

Entry Points: VECTOR

Called By: FUNCT

External References: EXIST, SOPEN, PLTBND, SREAD, SETSUB, LINPLT

Common Blocks: CONSTS, SUBSBK, GRDATA, SCCNTL

Calling Sequence: L

Processor: EDIT

Variable	Description
L	Number of the plot.

Element Description: VECTOR plots the velocity vector field. VECTOR also calls PLTBND to plot the boundary. It should be noted that VECTOR requires equal X-Y scaling be specified in PAPER. VECTOR makes one pass over the drum file.

Abort Conditions: None

Messages to Printer: None

Element Name: VISCOS Element Type: FORTRAN Subroutine

Entry Points: VISCOS

Called By: STRESS

External References: DIVU, PLASFL

Common Blocks: EOSBLK, CONSTS, SUBSBK, GRDATA, RCDATA, DIVUBK, DSTARS

Calling Sequence: IT, JT, SXX, SYY, STT TXY

Processor: INTEG

Variable	Description
IT, JT	Column and row indices for cell under consideration.
SXX SYY STT TXY	Deviatoric components of stress.

Element Description: VISCOS calculates artificial viscosity.

Abort Conditions: None

Messages to Printer: None

Element Name: VOLCEL

Element Type: FORTRAN Real Function Subroutine

Entry Points: VOLCEL

Called By: PRNTIJ, REGION, HYPOEL, PHASEA, STRESS, STRFLO, MASFLO, VARIBL

External References: GETCON, ARECEL, SAVSUB, GETIJ, ABORT

Common Blocks: CONSTS, SUBSBK, CUTBLK, RCDATA

Calling Sequence: L, MODE

Processor: I.C., INTEG, EDIT

Variable	Description
L	Subscript to cell dictionary.
MODE	= 1; For regular cell. = 2; For lattice cell.

Element Description: VOLCEL calculates the volume of a lattice or regular cell depending on mode.

Abort Conditions: VOLCEL - The cell under consideration was cut but but there was no location assigned to retrieve the area or volume from CUTBLK.

Messages to Printer: None

Element Name: YLD

Element Type: FORTRAN Real Function Subroutine

Entry Points: YLD

Called By: PLASFL

External References: None

Common Blocks: EOSBLK

Calling Sequence: SF, EP

Processor: INTEG

Variable	Description
SF	Logical variable which is true if work hardening is used.
EP	Plastic strain.

Element Description: YLD provides the yield criterion when the von Mises criterion is not being used.

Abort Conditions: None

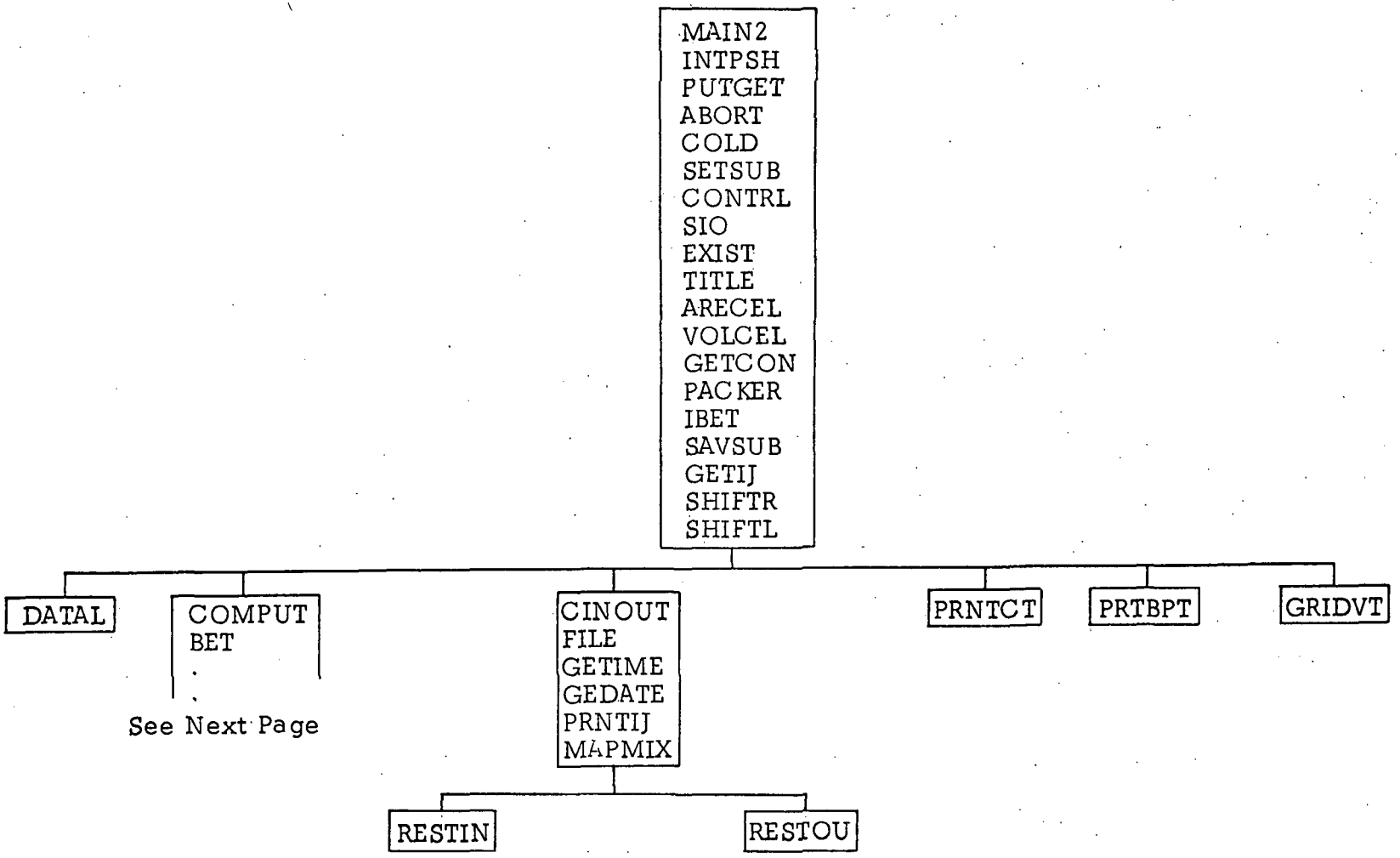
Messages to Printer: None

3.3 COLLECTOR SOURCE ELEMENTS

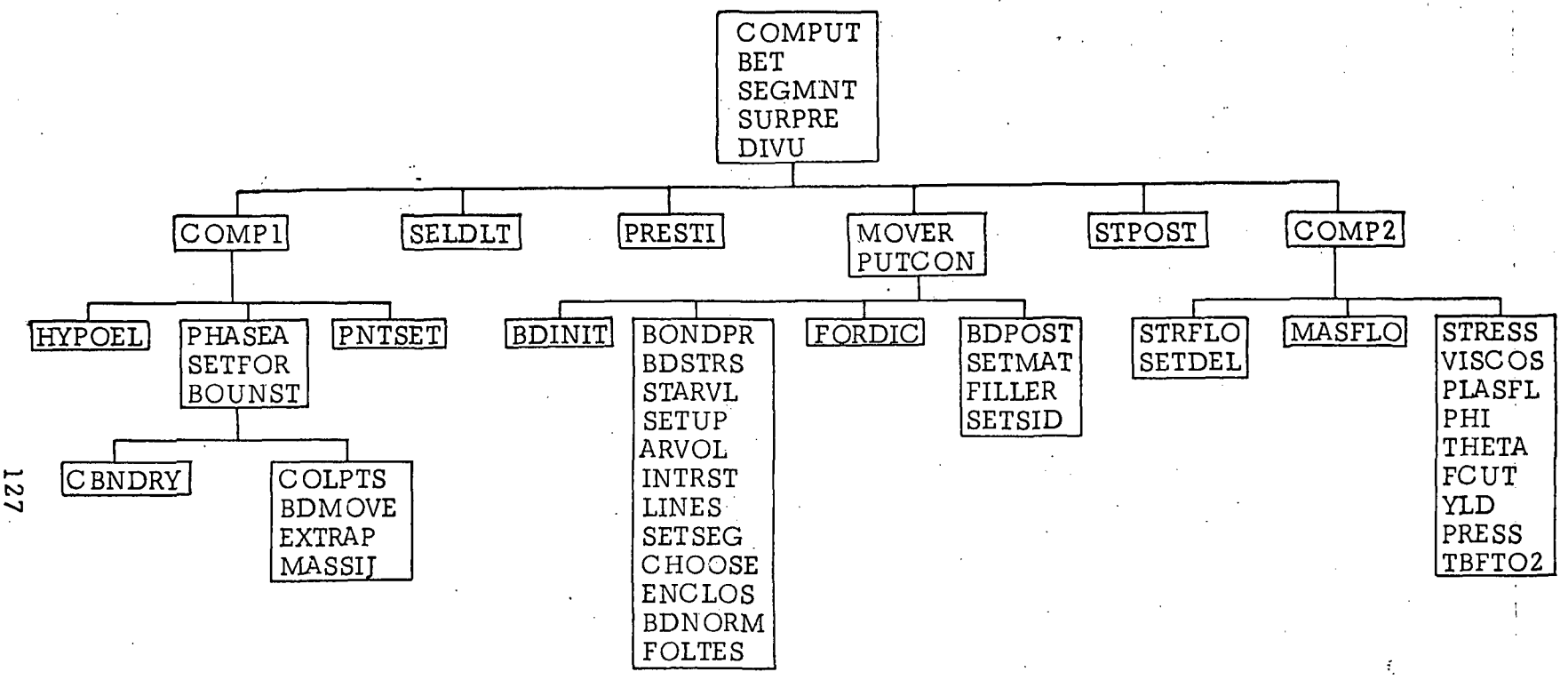
There are three COLLECTOR source elements in STEEP32. These are MAIN1, MAIN2, and MAIN3. These elements determine the memory allocation structure for each of the three main processors of STEEP32. The COLLECTOR source language is described in Section 6.6 of the Marshall Space Flight Center Programmer's Procedure Manual. The primary output from the COLLECTOR is the absolute or relocatable element which will be executed on the UNIVAC 1108. It should be noted that the structure defined by the COLLECTOR also determines the amount of core required by a program. With judicious modification of the memory allocation scheme for a particular STEEP32 problem it might in some cases be possible to reduce the amount of storage required.

The three diagrams on the following pages indicate the memory allocation scheme for the three main processors of STEEP32.

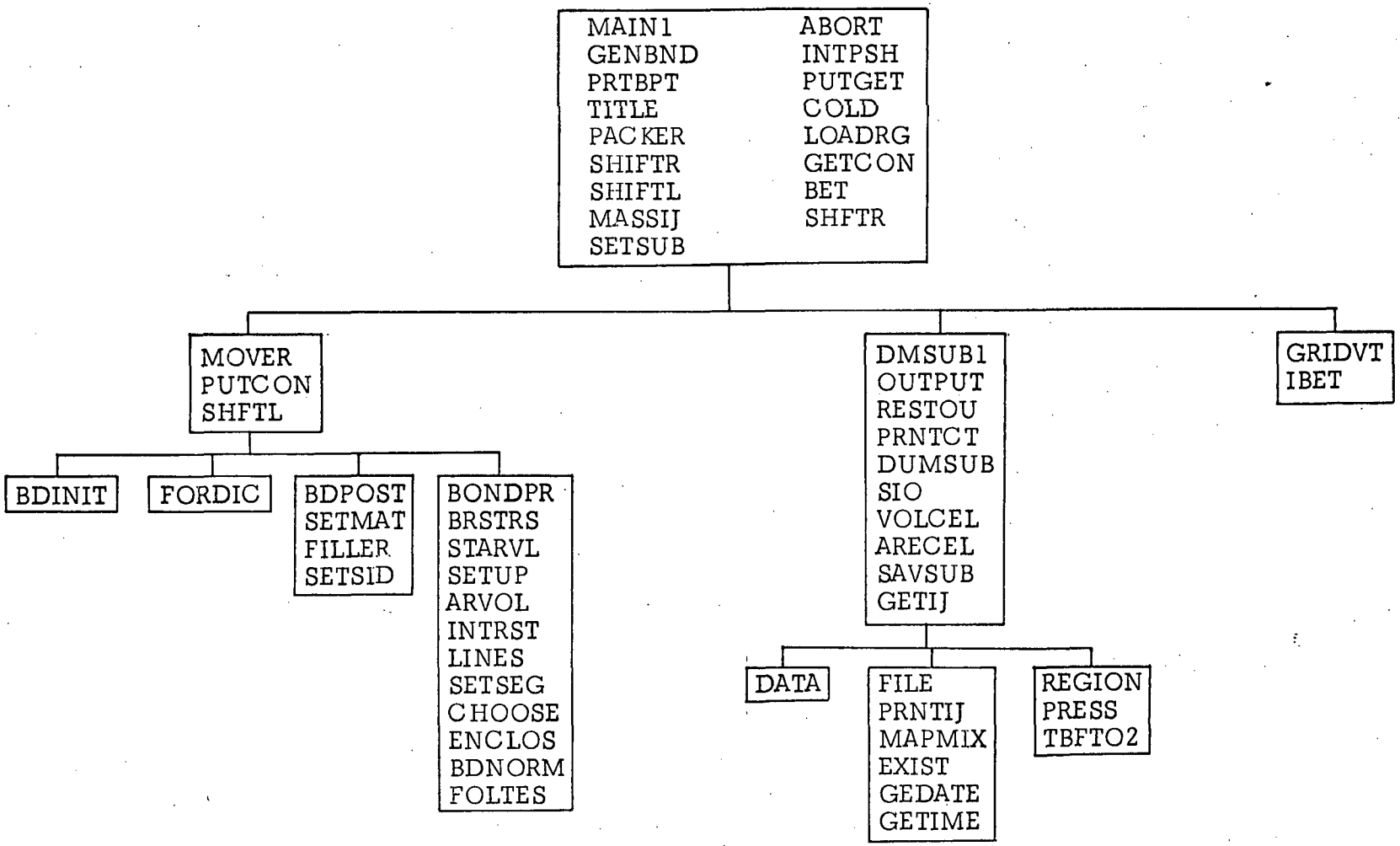
MEMORY ALLOCATION SCHEME FOR THE INTEGRATION PROCESSOR



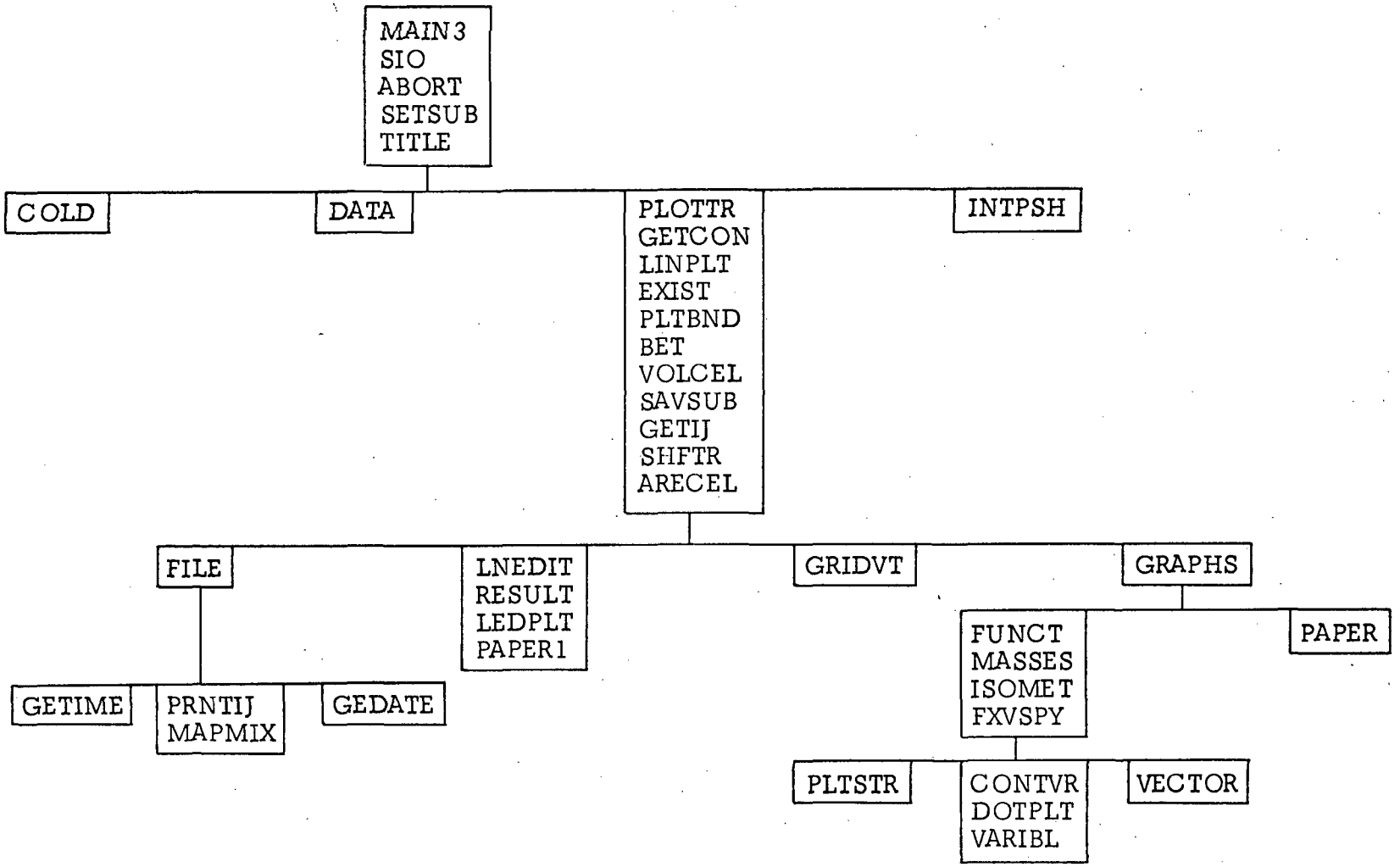
MEMORY ALLOCATION SCHEME FOR THE INTEGRATION PROCESSOR (Continued)



MEMORY ALLOCATION SCHEME FOR THE INITIAL CONDITIONS PROCESSOR



MEMORY ALLOCATION SCHEME FOR EDIT PROCESSOR



SECTION 4

STEEP32 COMMON BLOCKS

In this section each common block is described. A list of subroutines referencing the common block is given to aid any user desiring to make code changes. Finally, an extensive description of the variables in each common block appears. Several very important conventions involving the cell dictionary, the association of cut cell information and the location of the cell variables are described here.

COMMON BLOCK BOUNDY

Used By: BDINIT, BDNORM, BDPOST, BDSTRS, BONDPR, COLDTS, CONTRL, DATA, FILE, GENBND, INTPSH, MOVER, PLASFL, PLTLNT, PNTSET, PRTBPT, PUTGET, STRESS.

Variable	Description
ENDSTR	A logical variable which is set to true if the last point of a string is being processed.
STRTSW	A logical variable which is set to true if the first point of a string is being processed.
NBOUND	The total number of cut cells. NBOUND is used by FILE and INTPSH.
NEXT	Is the next available location in the push down list. NEXT is set by PUTGET.
POS	Logical variable which is true when a real string is being processed.
NSTRG	The number of string in the problem.
MSTRG (NUMSTG)	The number of string points in each string.
XSTRG (NUMSTP)	The x-coordinates of the string points.
YSTRG (NUMSTP)	The y-coordinates of the string points.
LSTRG (NUMSTP)	The dictionary or control word for each string point.

COMMON BLOCK CBLOCK

Used By: COLD, CONTRL, DUMSUB, DMSUB1, FILE, GETCON, MASFLO, PHASEA, PRNTCT, PRNTIJ, PUTCON, SETDEL, STRESS, STRFLO

CBLOCK contains only one array, the cell dictionary array - C(NUMCEL). The cell dictionary has one word for each cell of a STEEP32 problem. Into this word certain information about the cell is packed. To extract information from the cell dictionary it is necessary to mask the word and shift the result. For this purpose the constant arrays MASK and SHIFT are used. The subscripts of MASK and SHIFT have been given names according to the following convention:

C = regular cell
L = lattice cell
S = segment
H = horizontal
V = vertical

Variable Name	Number of Bits	Description
CMAT	2	Cell material 0 = empty, 1 = part filled, 2 = filled.
LMAT	2	Lattice material 0 = empty, 1 = part filled, 2 = filled.
CHS*	3	Cell horizontal segment type.
CVS*	3	Cell vertical segment type.
LHS*	3	Lattice horizontal segment type.
LVS*	3	Lattice vertical segment type.
LPT	1	Lattice point at n + 1, 0 = outside of mass, 1 = inside of mass.
CN	1	Cell at n, 0 = no mass, 1 = mass.
CNP	1	Cell at n + 1, 0 = no mass, 1 = mass.
LN	1	Lattice point at n, 0 = outside, 1 = inside.
LNP	1	Not used.

Common Block CBLOCK (concluded).

Variable Name	Number of Bits	Description
LOC	10	Data location. If cell is cut this field will contain the location in CUTBLK to use to obtain the area and volume information.

*Segment types serve to establish which part of the cell segments contain mass. The meanings of the different values are as follows:

Value	Definition
0	No mass
1	Cell mass
2	Mass, no mass
3	No mass, mass
4	No mass, mass, no mass
5	Mass, no mass, mass

COMMON BLOCK CONSTS

Used By: ARECEL, BDINIT, BDMOVE, BDPOST, BONDPR, CBNDRY, COLD, COMP1, COMP2, COMPUT, CONTRL, CONTUR, DATA, DATAL, DIVU, DMSUB1, DUMSUB, EXIST, EXTRAP, FILE, FILLER, FORDIC, GENBND, GETCON, GRIDVT, HYPOEL, LNEDIT, MAIN1, MAIN2, MAIN3, MAPMIX, MASFLO, MASSIJ, PAPER, PAPER1, PHASEA, PLASFL, PLTSTR, PRNTCT, PRNTIJ, PUTCON, REGION, RESULT, SEGMNT, SELDT, SETDEL, SETFOR, SETMAT, SETSEG, SETSUB, SIO, STARVL, STRESS, STRFLO, TITLE, VARIBL, VECTOR, VISCOS, VOLCEL

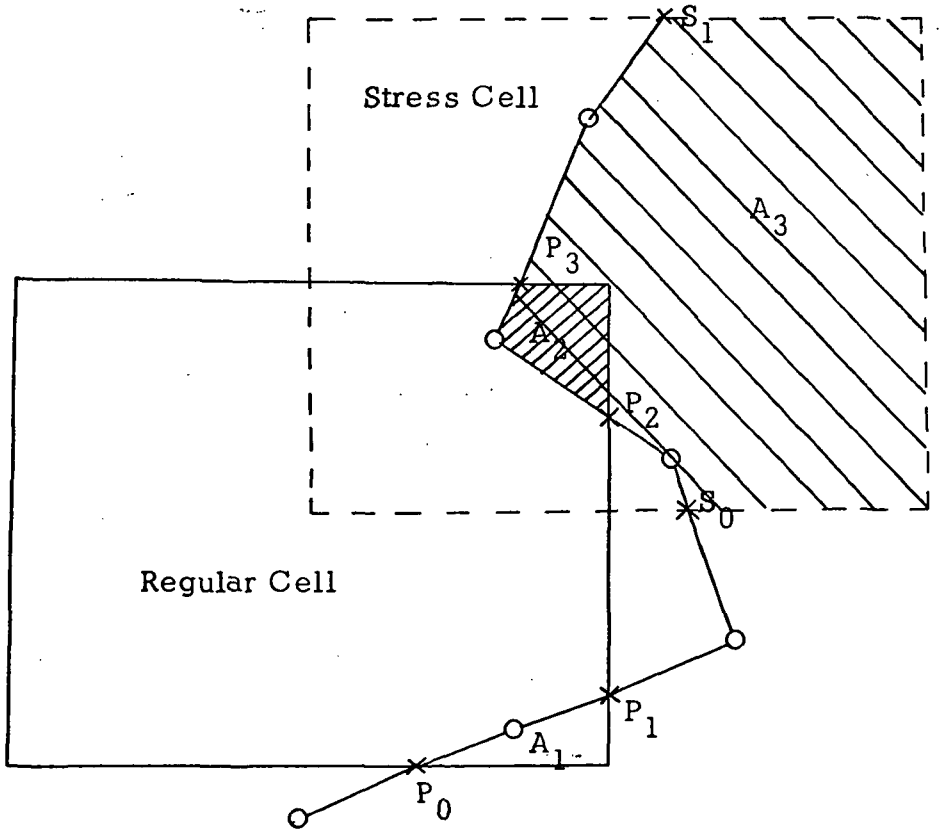
CONSTS contains most of the undimensioned constant variables. The majority of these variables are set by the namelist INITAL and are defined in the description of that namelist. The exceptions fall into two categories. CMAT, LMAT, CHS, CVS, LHS, LVS, LPT, CN, CNP, LN, LNP, LOC, MASK, and SHIFT all are used in conjunction with the cell dictionary word and are described with CBLOCK. STOPOP, STOPSM, STOPDT, STOPCY, STOPTI, STOPRT, STOPFO, STOPIL, STOPIR, STOPJL, STOPJU indicate the conditions which caused the problem to stop. These logical variables are set to true under the following conditions;

Variables	Description
STOPOP	The operator has set sense switch 5 down. This is no longer used.
STOPSM	The value of the variable SMAX exceeds the maximum value allowed.
STOPDT	DT is less than DTMIN.
STOPCY	Current cycle exceeds MAXCYC-1.
STOPTI	Current time exceeds TMAX.
STOPRT	Not used.
STOPFO	The string has folded.
STOPIL	Motion on right hand boundary was sensed and SPRITE was true.
STOPIR	Motion on left hand boundary was sensed and SPLEFT was true.
STOPJL	Motion on bottom boundary was sensed and SPLOWR was true.
STOPJU	Motion on upper boundary was sensed and SPUPPR was true.

COMMON BLOCK CUTBLK

Used By: ARECEL, BDPOST, COLD, CONTRL, FILE, GENBND, HYPOEL, MASFLO, PHASEA, PLASFL, PRNTIJ, PRTBPT, PUTGET, SEGMNT, SETDEL, SETFOR, SETMAT, SETSEG, SETUP, STARVL, STPOST, STRFLO, VOLCEL.

CUTBLK contains all the data for cut cells. Whenever a cell is cut, special information must be retained. Part of the information appears in the dictionary as segment types. The remaining data is referenced using the field LOC in the dictionary. If the dictionary is nonzero, either the regular cell or the stress cell is cut and the following information is recorded in CUTBLK: AREAC, AREAL, VOLS, VOLL, AL, RA, RB.



AREAC / VOLC } is { Area / Volume } of $(A_1 + A_2)$

AREAL / VOLL } is { Area / Volume } of A_3

RA: P_1 is the first intersection on vertical segment.

RB: P_2 is second intersection on vertical segment.

RA: P_3 is only intersection on horizontal segment.

RA: S_1 is only intersection on horizontal segment.

AL: At P_3 the outer normal angle to the surface is stored for horizontal segment. At P_1 and P_2 since the vertical segment is cut two time the outer normal is not used, although one may be stored (depending on the ordering of the calculations the angle may be that associated with P_1 or P_2).

Points P_o and S_o are associated with adjacent cells.

COMMON BLOCK DELSBK

Used By: COLD, CONTRL, CONTUR, HYPOEL, MASFLO, PHASEA, PRNTIJ, SETDEL, SETFOR, STRESS, STRFLO

DELSBK contains the communication data used with the flow of deviatoric stress.

Variable	Description
SXXH SYYH STTH TXYH	Flow terms across the horizontal face.
SXXV SYYV STTV TXYV	Flow terms across the vertical surface.
NOBDPT	The number of cuts in cell sides.
SINT COST	Not used.

COMMON BLOCK DIVUBK

Used By: DIVU, HYPOEL, PLASFL, STRESS, VISCOS

DIVUBK contains the communication data associated with the calculation of the divergence.

Variable	Description
DXX	d_{rr}
DXY	d_{rz}
DYY	d_{zz}
DTT	$d_{\theta\theta}$
DX	Length of cell side in x direction.
DY	Length of cell side in y direction.
Omega	Spin
DMM	d_{mm}
PARTVL	Particle velocity.

COMMON BLOCK DSTARS

Used By: STRESS, VISCOS

DSTARS contains the communication information between VISCOS and STRESS.

Variable	Description
DTTS	$d^*_{\theta\theta} = d_{\theta\theta} - d_{mm}$
DXXS	$d^*_{rr} = d_{rr} - d_{mm}$
DXYS	$d^*_{rz} = d_{rz}$
DYYS	$d^*_{zz} = d_{zz} - d_{mm}$

COMMON BLOCK EOSBLK

Used By: PRESS, REGION, STRESS, TBFTO2, VISCOS, YLD

EOSBLK contains the communications data for the equations of state computations.

Variable	Description
K	Pointer to the first PCON constant.
PRES	Pressure
VL	The sound speed squared.
ETAL	Relative density at lattice point.
EL	Specific internal energy at the lattice point.

COMMON BLOCK FRSTBK

Used By: COMPUT, MAIN2

FRSTBK contains the logical variable FIRST. FIRST is set to true when the first cycle following a refresh is being integrated. This information is used to suppress the calculation of Δt for that.

COMMON BLOCK GRDATA

Used By: BDMOVE, BOUNST, COLD, CONTRL, DMSUB1, DUMSUB, FILE, HYPOEL, LNEDIT, MASFLO, PHASEA, PLTSTR, PRNTIJ, REGION, RESULT, SETDEL, SETFOR, SIO, STRESS, STRFLO, VARIBL, VECTOR, VISCOS

GRDATA contains the core buffers for the cell variables. The names of the variables which are contained in GDATA depend on the stage of the calculation one is looking at. The following table establishes the relationship between the various cell variables and the subscripts of GRDATA.

GRDATA Location	Pass 1			Pass 2	
	COMP1 Read (Values at n)	COMP1 Write COMP2 Read		COMP2 Write (Values at n + 1)	
	Value	Value	By	Value	By
1	E	ETOT	PHASEA	E	MASFLO
2	MASS	MASS	---	MASS	MASFLO
3	TTT	STTA	HYPOEL	TTT	STRESS
4	TXX	SXXA	HYPOEL	TXX	STRESS
5	TXY	TXYA	HYPOEL	TXY	STRESS
6	TYY	SYYA	HYPOEL	TYY	STRESS
7	U	UAVE	PHASEA	U	MASFLO
8	V	VAVE	PHASEA	V	MASFLO
9	DSXX	STTEST	HYPOEL	DSXX	STRESS
10	DSYY	SXXEST	HYPOEL	DSYY	STRESS
11	DSTT	TXYEST	HYPOEL	DSTT	STRESS
12	DSXY	SYYEST	HYPOEL	DSXY	STRESS
13	---	UEST	PHASEA	---	---
14	---	VEST	PHASEA	---	---
15	---	EEST	PHASEA	---	---
16	---	TH	PHASEA	---	---

COMMON BLOCK IOCNTL

Used By: ABORT, BDMOVE, BONDPR, COLPTS, CONTRL, DATA, DATAL, FILE, GENBND, GRAPHS, HYPOEL, LEDPLT, LNEDIT, MAIN3, MAPMIX, MASFLO, PHASEA, PLOTTR, PRNTCT, PRNTIJ, PRTBPT, REGION, RESTIN, RESTOU, RESULT, SELDT, SEGMNT, SETDEL, SETFOR, SIO, STRESS, STRFLO, TITLE

IOCNTL contains all logical unit assignments.

Variable	Description
INP	Input unit corresponding to card reader. Currently has value 5.
OUT	Output unit corresponding to line printer. Currently has value 6.
BIN	Unit for the input restart tape.
BOU	Unit for the output restart tape.
PLT	Unit for the SC4020 plot tape if any.
SIN	Scratch drum file for read.
SOU	Scratch drum file for write.
FRESH	Logical variable which is set to true when machine has been refreshed.

COMMON BLOCK MATBLK

Used By: COMPUT, CONTRL, DATA, DATAL, FILE, HYPOEL, LOADRG, PLASFL, PRESS, REGION, STRESS, STRFLO

MATBLK contains the material defining data.

Variable	Description
TWOMU	$2 \cdot \mu$ where μ is the shear modulus.
KTYPE	Not used.
YIELD	Coefficients to use in yielding.
LFIT	Equation of state number.
LPOINT	Pointer to location in PCON table to start.
VONMIS	A logical variable which is set to true by the user if he desires the Von Mises yield criterion to be employed.

COMMON BLOCK NETBLK

Used By: CONTRL, DATA, DMSUB1, DUMSUB, GRIDVT, LOADRG

NETBLK contains all the information necessary to generate the grid.

Variable	Description
NOX	The number of x's used to specify grid.
NOY	The number of y's used to specify grid.
NEWXYS	Logical variable not currently used.
X(I)	x values to start equal spacing.
Y(J)	y values to start equal spacing.
DX(I)	Value to use to generate grid between X(I) and X(I + 1).
DY(J)	Value to use to generate grid between Y(J) and Y(J + 1).

COMMON BLOCK PCNBLK

Used By: DATA, DATAL, DMSUB1, DUMSUB, GRIDVT, LOADRG

PCNBLK contains all the equation of state parameters.

Variable	Description
PCON	Array containing the equation of state parameters. The interpretation of the subscripts for PCON vary depending on the equation of state used.

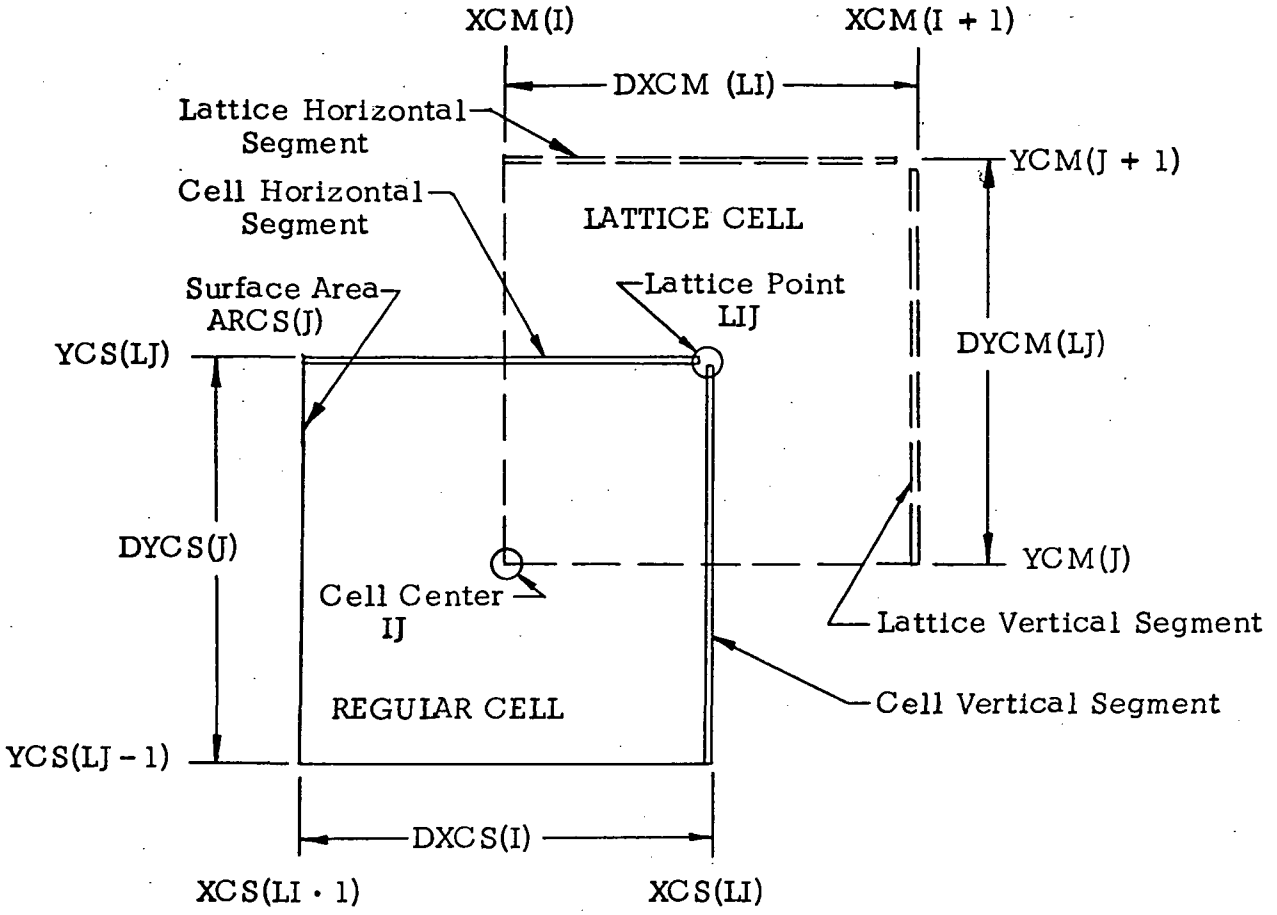
COMMON BLOCK RCDATA

Used By: ARECEL, BDMOVE, BDNORM, BDPOST, BDSTRS, COLD, COLPTS, CONTRL, CONTUR, DATA, DIVU, FILE, GENBND, GRIDVT, HYPOEL, LNEDIT, MASFLO, MASSIJ, PHASEA, PLASFL, PLTSTR, PRNTIJ, REGION, RESULT, SEGMNT, SETDEL, SETFOR, STRESS, STRFLO, VECTOR, VISCOS, VOLCEL

RCDATA contains all the row and column vectors describing the problem grid.

Variable	Equivalent Name	Description
RDATA(1,1)	YCS(1)	y coordinate of regular cell side.
RDATA(1,2)	YCM(1)	y coordinate of stress cell side.
RDATA(1,3)	DYCS(1)	Length of regular cell side in y direction.
RDATA(1,4)	DYCM(1)	Length of stress cell side in y direction.
RDATA(1,5)	ARCS(1)	Cross-sectional area for regular cell.
RDATA(1,6)	ARCM(1)	Cross-sectional area for stress cell.
CDATA(1,1)	XCS(1)	x coordinate of regular cell side.
CDATA(1,2)	XCM(1)	x coordinate of stress cell side.
CDATA(1,3)	DXCS(1)	Length of regular cell side in x direction.
CDATA(1,4)	DXCM(1)	Length of stress cell side in x direction.

Association of cells, rows, columns, and segments (core file) RCDATA



Subscription columns (I, LI) and rows (J, LJ)

I takes on values	IMIN	thru	IMAX
J takes on values	JMIN	thru	JMAX
LI takes on values	LIMIN	thru	LIMAX
LJ takes on values	LJMIN	thru	LJMAX

Given I and J, or LI and LJ, subroutine SETSUB will compute IJ and/or LIJ and IJD.

IJ and LIJ are addresses in the grid buffers (GRDATA). IJD is adress in dictionary.

COMMON BLOCK RCTEMP

Used By: CONTRL, CONTUR, MAPMIX, MASFLO, PHASEA, PRNTIJ, SETDEL, SETFOR, STRFLO

RCTEMP contains the row and column scratch information.

Variable	Equivalent Name	Description
RTEMP(1,1)	DEH(1)	The change in energy across the horizontal surface of a cell.
RTEMP(1,2)	DEV(1)	The change in energy across the vertical surface of a cell.
RTEMP(1,3)	DMH(1)	The change in mass across the horizontal surface of a cell.
RTEMP(1,4)	DMV(1)	The change in mass across the vertical surface of a cell.
RTEMP(1,5)	DUH(1)	The change in U momentum across the horizontal surface of a cell.
RTEMP(1,6)	DUV(1)	The change in U momentum across the vertical surface of a cell.
RTEMP(1,7)	DVH(1)	The change in V momentum across the horizontal surface of a cell.
RTEMP(1,8)	DVV(1)	The change in V momentum across the vertical surface of a cell.

COMMON BLOCK REGBLK

Used By: CONTRL, DATA, DMSUB1, DUMSUB, LOADRG, REGION

REGBLK contains the region specifications which are used to define the initial conditions. The definition of the variables used in REGBLK can be found with the namelist INITAL. The variables in REGBLK are: NREG, XLREG, XRREG, YLREG, YUREG, UREG, VREG, EREG, RHOREG, STTREG, SXXREG, SYYREG, TXYREG, REGTYP.

COMMON BLOCK SCANBK

Used By: BDPOST, CONTRL, SETSID

SCANBK contains the communication data for the dictionary manipulation.

Variable	Description
MD	The dictionary subscript for the cell.
MA	The minimum column number minus 1.
MB	The maximum column number.
ME	The column offset for the dictionary.
LA	The minimum row number.
LB	The maximum row number.
LE	The row offset for the dictionary.
KEY	The key to the segment being considered.

COMMON BLOCK SCCNTL

Used By: CONTRL, CONTUR, FUNCT, GRAPHS, LEDPLT, LNEDIT, PAPER, PAPER1, PLOTTR, PLTBND, PLTSTR, RESULT, VECTOR

SCCNTL contains all the control information for the SC4020 edits. The relevant variables are documented with the namelist SC4020.

COMMON BLOCK SCDEPS

Used By: LEDPLT, LNEDIT, PAPER, PAPER1, PLOTTR, RESULT

SCDEPS contains all the variables connected with the linear editor. These variables are discussed in the linear editor documentation.

COMMON BLOCK SEGBLK

Used By: BOUNST, COLD, CONTRL, CONTUR, HYPOEL, MASFLO, PHASEA, PRNTIJ, SEGMNT, SETDEL, SETFOR, STRESS, STRFLO

SEGBLK contains information relating to the segment computations.

Variable	Description
NOSEG	The number of segments in cell side under consideration.
NOCUT	The number of cuts.
XA	y coordinate of intersection on a vertical segment.
XB	x coordinate of intersection on a horizontal segment.

COMMON BLOCK SHCOM

Used By: COLD, COMPUT, CONTRL, DATA, FILE, GENBND, PLASFL, PRTBPT, STPOST, STRESS

SHCOM contains the communication data used in work hardening and the Perzyna model.

Variable	Description
SF	Logical variable which is true if work hardening is to be performed.
NIM	The number of imaginary string points in problem.
XBCOMP	x coordinate of left side of column.
XTCOMP	x coordinate of right side of column.
DXCRAT	Distances in x direction from the center of the current column to each of the imaginary string points.
LPNT	An array used by PLASFL to temporarily store subscripts of the imaginary string points which are being used for the work hardening calculations.

COMMON BLOCK SIOBLK

Used By: MAIN1, MAIN2, SIO

SIOBLK contains three logical variables.

Variable	Description
CLOSED	Logical variable which is set to true if the file has been closed.
OPEN	Logical variable which is set to true if the file has been opened.
NEVER	Logical variable which has the value true if the file has never been written.

SECTION 5

INPUT DATA TO STEEP32

Most input variables to STEEP32 occur in one or more namelist. A particular namelist may be referenced by more than one processor. The sequence of the input data for each processor is described below. This is followed by a detailed description of each of the namelists.

5.1 SEQUENCE OF INPUT DATA

5.1.1 Initial Conditions

$INITAL

.
.

data for the INITAL namelist

.
.

$END

Heading card

STARTR card

$BDSTRG

.
.

string data for problem

.
.

$END

CUTOFF card.

The heading card is a card with an alphanumeric description of the problem in columns 1 to 72. The STARTR card has the word STARTR in columns 11 to 16. The CUTOFF card has the word CUTOFF in columns 11 to 16.

5.1.2 Integration

Tape Card

$DATAL2

.
.

specific data for problem

.
.

$END

Heading card if the logical variable NEWHED is set to true.

The format of the tape card is 5I4. The variables appearing on it are BIN, BOT, SIN, SOU, and INFILE. These variables are the restart input tape, the restart output tape, the two scratch drum units, and the file number to use for restart. As with the initial conditions, the heading card contains 72 columns of alphanumeric information.

5.1.3 Edit

```
$INITAL
   .
   .
   BIN, SIN, and SOU must be set here
   .
   .
$END

   EDIT card

$SC4020
   .
   .
   data for plots
   .
   .
$END
```

Heading Card
Label Card } NGRAPH pairs of these must appear if the logical variable NEWHED is true.

The EDIT card must have the word EDIT appearing in columns 11 through 14.

```
$RSTART
   .
   .
   INFILE must be set here
   .
   .
$END
```

```
C  5.2  NAMELIST DESCRIPTIONS
C
C      5.2.1 THE NAMELIST INITAL
C
C
C      THE VARIABLES FOR THE NAMELIST INITAL ARE DIVIDED INTO GROUPS
C      ACCORDING TO THEIR FUNCTION.
C      WITHIN EACH GROUP THE DESCRIPTION OCCURS IN FOUR COLUMNS. THE
C      FIRST COLUMN GIVES THE VARIABLE NAME. THE SECOND COLUMN GIVES
C      THE VARIABLE DESCRIPTION. THE THIRD COLUMN INDICATES THE VARIABLE
C      TYPE. THE FOURTH COLUMN DEFINES THE ASSUMED VALUE THE VARIABLE IS
C      ASSIGNED.
C CONTROL DATA
C      BIN                 INPUT RESTART TAPE                I    0
C      BOT                 OUTPUT RESTART TAPE               I    0
C      CYCLE               CYCLE NUMBER                      I    0
C      DT                  INTEGRATION STEP                  R    .1
C      DTMIN               MINIMUM DT                        R    .01
C      FRESH               MACHINE STATUS.                   L    .FALSE.
C                          IF FRESH IS TRUE, THEN THERE
C                          IS A GOOD FILE ON DRUM FILE
C                          SIN.
C      MAXCYC              MAXIMUM NUMBER INT. CYCLES        I    200
C      NBOUND              MAXIMUM NO. BOUNDARY CELLS        I    100
C      NPAUSE              OUTPUT FREQUENCY                  I    1
C      SF                  TRUE FOR STRAIN HARDENING         L    .FALSE.
C      SIN                 SCRATCH INPUT FILE                I    15
C      SOU                 SCRATCH OUTPUT FILE               I    16
C      TIME                TIME                              R    0.
C      TMAX                MAXIMUM INT. TIME                 R    0.
C      NEWHED              HEADER CARD READ CONTROL          L    .FALSE.
C GEOMETRY AND BOUNDARY DATA
C      GEOM                GEOMETRY 1=SLAB, 2=CYL.           I    0
C      LBRITE              RITE BOUNDARY 1=CONT.,2=FIXED     I    1
C      LBLOWR              LOWR BOUNDARY 1=CONT.,2=FIXED     I    1
C      LBLEFT              LEFT BOUNDARY 1=CONT.,2=FIXED     I    1
C      LBUPPR              UPPR BOUNDARY 1=CONT.,2=FIXED     I    1
C      SPLEFT              STOP FOR MOTION LEFT  BNDY.       L    .FALSE.
C      SPRITE              STOP FOR MOTION RIGHT BNDY.       L    .FALSE.
C      SPLOWR              STOP FOR MOTION LOWER BNDY.       L    .FALSE.
C      SPUPPR              STOP FOR MOTION UPPER BNDY.       L    .FALSE.
C      NCOL                NUMBER OF CELL COLUMNS            I    1
C      NROW                NUMBER OF CELL ROWS               I    1
C      NOX                 NUMBER OF X,DX COMBOS             I    0
C      X(1)                LEFT X'S                          R    0.
C      DX(1)               DX INCREMENTS                     R    0.
C      NOY                 NUMBER OF Y,DY COMBOS             I    0
C      Y(1)                LOWER Y'S                         R    0.
C      DY(1)               DY INCREMENTS                     R    0.
C      NREG                NUMBER OF REGIONS                 I    0
C      XLREG(1)            LEFTMOST X OF REGION              R    0.
C      XRREG(1)            RIGHTMOST X OF REGION             R    0.
C      YLREG(1)            LOWERMOST Y OF REGION             R    0.
C      YUREG(1)            UPPERMOST Y OF REGION             R    0.
C      EREG(1)             SPECIFIC INTERNAL VOLUMETRIC      R    0.
C                                ENERGY OF REGION
C      UREG(1)             X VELOCITY OF REGION              R    0.
C      VREG(1)             Y VELOCITY OF REGION              R    0.
C      RHOREG(1)                                             R    0.
C      TTTREG(1)           TTT STRESS OF REGION              R    0.
```

```
C      TXXREG(1)          TXX STRESS OF REGION              R     0.
C      TXYREG(1)          TXY STRESS OF REGION              R     0.
C      TYYREG(1)          TYY STRESS OF REGION              R     0.
C      REGTYP(I)          TYPE OF REGION (0=STANDARD)       I     0
C MATERIAL DATA
C      TWOMU              2*MU FOR STRENGTH EFFECTS         R     0.
C      VONMIS             VON MEISIS CRITERION              L     .TRUE.
C      YIELD              YIELD CONSTRAINT. IF=0.,NONE      R     0.
C EQUATION OF STATE DATA
C      LFIT(1)            EOS FORM                          I     0
C      LPOINT(1)          POINTER TO EOS DATA               I     1
C      PCON(1)            EOS DATA                          R     0.
C      PCONTB             CONTROL FOR READING PCON DATA     L     F
C STABILITY DATA
C      S1                 STABILITY CONTROL S1              R     .16
C      S2                 STABILITY CONTROL S2              R     .35
C      R1                 INCREASE FACTOR FOR DT            R     1.5
C      R2                 DECREASE FACTOR FOR DT            R     .5
C TOLERANCES
C      PTOL               MINIMUM ABSOLUTE PRESSURE         R     1.E-6
C      DUTOL              TOLERANCE ON DU (ABS)             R     1.E-6
C      DVTOL              TOLERANCE ON DV (ABS)             R     1.E-6
C      DXTOL              MINIMUM DX FOR BOUNDARY POINT     R     .001
C      DYTOL              MINIMUM DY FOR BOUNDARY POINT     R     .001
C      ETOL               TOLERANCE ON E   (ABS)            R     1.E-6
C      RHOTOL             TOLERANCE ON RHO (ABS)            R     1.E-6
C      STTTOL             TOLERANCE ON TTT (ABS)            R     1.E-6
C      SXXTOL             TOLERANCE ON TXX (ABS)            R     1.E-6
C      SXYTOL             TOLERANCE ON TXY (ABS)            R     1.E-6
C      SYYTOL             TOLERANCE ON TYY (ABS)            R     1.E-6
C      UTOL               TOLERANCE ON U   (ABS)            R     1.E-6
C      VOLTOL             TOLERANCE ON REL. VOLUME          R     .1
C                              FOR ACCELERATION, WORK
C      VTOL               TOLERANCE ON V   (ABS)            R     1.E-6
C VISCOSITY DATA
C      COEVIS(1)          LINEAR, QUADRATIC, DEVIATOR       R     0.
C                              VISCOSITY COEFFICIENTS
C      QMAX(1)            (UNUSED)
C$
C
@@
```

C 5.2.2 THE NAMELIST BDSTRG
C
C
C THE NAMELIST BDSTRG IS USED TO DEFINE THE STRING POINTS.
C

C VARIABLE NAME	DESCRIPTION	TYPE	ASSUMED VALUE
C EPS	INITAL EPS STRAIN HARDENING	R	0.
C NIM	IF(SF)NUMBER OF STRAIN POINTS STRAIN POINTS MUST PRECEDE EITHER OTHER IMAGINAY POINTS OR OTHER REAL STRING PNTS. NIM MUST BE .GE. 4	I	0
C NSTRG	NUMBER OF STRINGS	I	0
C MSTRG(1)	NUMBER OF POINTS PER STRING IF NEGATIVE, DUMMY STRING OR STRAIN HARDENING POINTS	I	0
C XSTRG(1)	X COORDINATE OF STRING POINT	R	0.
C YSTRG(1)	Y COORDINATE OF STRING POINT	R	0.

C
C NOTE THAT THERE ARE TWO TYPES OF STRINGS, IMAGINARY AND REAL. THE
C REAL STRINGS DEFINE MATERIAL. AS THE SUBCRIPTS OF THE STRING
C POINTS INCREASE, THE MATERIAL LIES TO THE RIGHT. SINCE STEEP32 IS
C A SINGLE MATERIAL CODE, THIS IMPLIES THAT THERE IS VOID ON THE
C LEFT OF THE STRING. IMAGINARY STRING POINTS DO NOT DEFINE MATERIAL
C AND AS SUCH THEY HAVE NO EFFECT ON THE AREA AND VOLUME
C CALCULATIONS. IMAGINARY STRING SERVE FIRST OF ALL TO TRACE
C MATERIAL FLOW. IN PROBLEM USING STRAIN HARDENING THEY MAY
C ALSO BE USED TO CARRY THE PLASTIC STRAINS.
C
C
C 5.2.3 THE NAMELIST RSTART
C
C
C THE NAMELIST RSTART IS USED TO CONTROL THE RESTART FILE THAT
C THE EDIT PROCESSOR IS PLOTTING FROM.
C

C VARIABLE NAME	DESCRIPTION	TYPE	ASSUMED VALUE
C INFILE	FILE NUMBER FOR REFRESHING	I	0.

@@

C 5.2.4 THE NAMELIST DATAL2
C
C THE NAMELIST DATAL2 IS READ BY THE INTEGRATION PROCESSOR TO
C CHANGE VARIABLES FROM THOSE VALUES THEY HAD ON THE RESTART TAPE.
C SOME OF THE VARIABLES SUCH AS MAXCYC WILL GENERALLY REQUIRE
C RESETTING WITH EACH RESTART.
C
C

NAME VARIABLE	DESCRIPTION	TYPE	VALUE ASSUMED
DT	INTEGRATION STEP	R	.1
NPAUSE	OUTPUT FREQUENCY	I	1
MAXCYC	MAXIMUM NUMBER INT. CYCLES	I	200
TMAX	MAXIMUM INT. TIME	R	0.
DTMIN	MINIMUM DT	R	.01
S1	STABILITY CONTROL S1	R	.16
S2	STABILITY CONTROL S2	R	.35
R1	INCREASE FACTOR FOR DT	R	1.5
R2	DECREASE FACTOR FOR DT	R	.5
DUTOL	TOLERANCE ON DU (ABS)	R	1.E-6
DVTOL	TOLERANCE ON DV (ABS)	R	1.E-6
TXXTOL	TOLERANCE ON TXX (ABS)	R	1.E-6
TXYTOL	TOLERANCE ON TXY (ABS)	R	1.E-6
TTTTOL	TOLERANCE ON TTT (ABS)	R	1.E-6
TYYTOL	TOLERANCE ON TYY (ABS)	R	1.E-6
UTOL	TOLERANCE ON U (ABS)	R	1.E-6
VTOL	TOLERANCE ON V (ABS)	R	1.E-6
ETOL	TOLERANCE ON E (ABS)	R	1.E-6
RHOTOL	TOLERANCE ON RHO (ABS)	R	1.E-6
TWOMU	2*MU FOR STRENGTH EFFECTS	R	0.
LFIT(1)	EOS FORM	I	0
LPOINT(1)	POINTER TO EOS DATA	I	1
PCON(1)	EOS DATA	R	0.
LBRITE	RITE BOUNDARY 1=CONT.,2=FIXED	I	1
LBLEFT	LEFT BOUNDARY 1=CONT.,2=FIXED	I	1
LBLOWR	LOWR BOUNDARY 1=CONT.,2=FIXED	I	1
LBUPPR	UPPR BOUNDARY 1=CONT.,2=FIXED	I	1
SPLEFT	STOP FOR MOTION LEFT BNDY.	L	.FALSE.
SPRITE	STOP FOR MOTION RIGHT BNDY.	L	.FALSE.
SPLOWR	STOP FOR MOTION LOWER BNDY.	L	.FALSE.
SPUPPR	STOP FOR MOTION UPPER BNDY.	L	.FALSE.
BIN	INPUT RESTART TAPE	I	0
BOT	OUTPUT RESTART TAPE	I	0
SIN	SCRATCH INPUT FILE	I	15
SOU	SCRATCH OUTPUT FILE	I	16
VOLTOL	TOLERANCE ON REL. VOLUME FOR ACCELERATION, WORK	R	.1
DXTOL	MINIMUM DX FOR BOUNDARY POINT	R	.001
DYTOL	MINIMUM DY FOR BOUNDARY POINT	R	.001
NEWHED	HEADER CARD READ CONTROL	L	.FALSE.
COEVIS(1)	LINEAR, QUADRATIC, DEVIATOR VISCOSITY COEFFICIENTS	R	0.
PTOL	MINIMUM ABSOLUTE PRESSURE	R	1.E-6
PCONTB	CONTROL FOR READING PCON DATA	L	F
VONMIS	VON MISES CRITERION	L	.TRUE.
SF	TRUE FOR STRAIN HARDENING	L	.FALSE.

@@

```
C      5.2.5  THE NAMELIST SC4020
C
C
C      THE NAMELIST SC4020 CONTAINS ALL THE VARIABLES USED TO DEFINE AN
C      SC4020 PLOT.
C
C
C      VARIABLE          DESCRIPTION                          TYPE  ASSUMED
C      NAME                                                         VALUE
C
C      PAPERT(1)         PAPER TYPE                           I     0
C                              =1 EQUAL X,Y SCALE
C                              =2 STANDARD GRID
C                              =3 ISOMETRIC
C      XMIN(1)           MINIMUM X FOR GRAPH                  R     0.
C      XMAX(1)           MAXIMUM X FOR GRAPH                  R     0.
C      YMIN(1)           MINIMUM Y FOR GRAPH                  R     0.
C      YMAX(1)           MAXIMUM Y FOR GRAPH                  R     0.
C      DELX(1)           DELTA X FOR GRAPH LINES              R     0.
C      DELY(1)           DELTA Y FOR GRAPH LINES              R     0.
C      ALPHA1(1)         ALPHA/1 FOR ISOMETRIC                R     0.
C      ALPHA2(1)         ALPHA/2 FOR ISOMETRIC                R     0.
C      FCLASS(1)         FUNCTION CLASSIFICATION              I     0
C     *                        =1 F(X) VS F(Y)
C                              =2 VELOCITY VECTORS
C     *                        =3 ISOMETRIC
C     *                        =4 MASS POSITIONS
C                              =5 CONTOURS
C                              =6 PRINCIPAL STRESS
C                              =7 MAXIMUM SHEAR
C     *                        NOT IMPLEMENTED AS OF 03/20/72
C      XSCALE(1)         DIVISOR FOR X FUNCTION               R     0.
C      TYPLEN(1)         TYPICAL LENGTHS FOR PLOTS            R     0.
C      YSCALE(1)         DIVISOR FOR Y FUNCTION               R     0.
C      FMIN(1)           MINIMUM LENGTH VECTOR PLOTTED        R     0.
C      FSCALE(1)         DIVISOR FOR VECTOR LENGTH            R     0.
C      FUNCX(1)          X FUNCTION IN FX VS FY               I     0
C      FUNCY(1)          Y FUNCTION IN FX VS FY               I     0
C       WHEN LNEDIT IS IMPLEMENTED FUNCX,FUNCY TAKE ON FOLLOWING VALUES
C      FUNCX(1)                 =1 OMEGA BAR
C                               =2 OMEGA
C      FUNCY(1)          FOR FUNCX=1 ONLY
C                              =1 CUMULATIVE MASS
C                              =2 CUMULATIVE KINETIC ENERGY
C                              =3 CUMULATIVE X-MOMENTUM
C                              =4 CUMULATIVE Y-MOMENTUM
C                              =5 CUMULATIVE MOMENTUM MAGNITUDE
C      FUNCY(1)          FOR FUNCY=2 ONLY
C                              =6 MASS PER STERADIAN
C                              =7 KINETIC ENERGY PER STERADIAN
C                              =8 X-MOM PER STERADIAN
C                              =9 Y-MOM PER STERADIAN
C                              =10MOM MAG PER STERADIAN
C      PLOT              PLOT CONTROL-IF F NO SC4020          L     T
C      LINEDT            LINEAR EXTRAP EDITOR CONTROL         L     F
C      NREGON            NO OF REG SGMTS IN DONOR REG         I     0
C      MINI(1)           MIN I VALUE FOR DONOR REG 1          I     0
C      MAXI(1)           MAX I VALUE FOR DONOR REG 1          I     0
C      MINJ(1)           MIN J VALUE FOR DONOR REG 1          I     0
C      MAXJ(1)           MAX J VALUE FOR DONOR REG 1          I     0
```

```
C     XEDIT          X VALUE FOR EXTRAPOLATION      R     0.
C     NSECTN         NO OF SECTIONS+1 AT XEDIT      I     0
C     SECTN(1)       Y-VALUE OF SECTION DIVISIONS   R     0.
C     ITYPE          LNEDIT PRINT CONTROL           I     0
C                          =1 CASE 1-XC,XMOM(J)
C                          =2 CASE 2-XC,X-AVE
C                          =3 CASE 3-XC,X-MASS-AVE
C                          =4 ALL CASES
C     CONI(1)        CONNECT EQUAL I IN FX VS FY    I     0
C     CONJ(1)        CONNECT EQUAL J IN FX VS FY    I     0
C     NGRAPH         NUMBER OF GRAPHS/FILE          I     0
C     NEDIT          NUMBER OF FILES TO EDIT        I     1
C     DOALL          CONTROL FOR ALL FILES/TAPE     L     F
C     CONTYP(1)      TYPE OF CONTOUR TO PLOT        I     0
C                          =1 SPECIFIC INTERNAL ENERGY
C                          =2 DENSITY
C                          =3 DYNAMIC PRESSURE
C                          =4 KINETIC ENERGY
C                          =5 MOMENTUM U-DIRECTION
C                          =6 MOMENTUM V-DIRECTION
C     NCONT(1)       NO. OF CONTOURS FOR EACH GRAPHI      0
C     POINTR(1)      POINTER TO 1ST VALUE IN TABLE  I     1
C     SPACNG(1)      TABLE OF CONTOUR VALUES        R     0.
C     REW            REWIND CONTROL BEFORE EDIT     L     T
C     IMINPT(1)      MIN I TO PLOT IN FX VS FY      I     0
C     IMAXPT(1)      MAX I TO PLOT IN FX VS FY      I     0
C     JMINPT(1)      MIN J TO PLOT IN FX VS FY      I     0
C     JMAXPT(1)      MAX J TO PLOT IN FX VS FY      I     0
C     CAMERA         CAMERA                         I     935
C     MAXFRM         MAXIMUM FRAME COUNT            I     50
C     NUM1           (NOT USED)                     I     0
C     NUM2           (NOT USED)                     I     0
C     NEWHED         CONTROL TO READ HEADING CARDS  L     T
C     LAST           CONTROL FOR END OF PLOTS       L     F
C     NDECL          THE NUMBER OF DECIMAL          I     2
C                    PLACES TO THE LEFT OF THE
C                    DECIMAL POINT TO BE USED
C                    IN LABELING THE X AND Y AXIS.
@@
```

SECTION 6

A DESCRIPTION OF THE PRINTED OUTPUT FROM STEEP32

The printed output from STEEP32 falls into four categories. These are the printout of input data, cycle by cycle printout, restart file printout and diagnostic printout.

6.1 INPUT DATA PRINTOUT

The printout of input data generally takes the form of a WRITE statement immediately following the READ statement used to input the data. Thus the format of this printout is the same as the input data described earlier.

6.2 CYCLE BY CYCLE PRINTOUT

An example of cycle by cycle printout appears on the next page. This group of print begins with the statement CYCLE=1 and continues through the next nine lines. The first line indicates the current cycle number and problem time. The next line contains totals for the mass, momenta, and energies in the problem. Lines three through six contain the peak stress and pressure as well as the indices of the cells where these peaks occur.

In the example given, the cycle 1 printout is followed by two lines and the message "TOTAL NEGATIVE ENERGY SUPPRESSED." These three lines are produced by subroutine MASFLO and are not part of the regular printout. Following these three lines of diagnostic printout the cycle by cycle print for cycle 2 begins.

```
FILE WRITTEN ON BOT= 6 NFILE=  2 CYCLE=     0 TIME=     0,0000     18 MAR 71   10:07:45     OUTPUT
        COMPUT

CYCLE=    1 TIME=     1,2700-02
MASS=     2,6998-01 UMOM=     0,0000     VMOM=     5,7725-02 K,E,=     2,1264-02 I,E,=     3,8321-04 T,E,=     2,1647-02
 TXXMAX=    ,47600-01 AT LI=  5 LJ= 13  TXXMIN=  -,84000-02 AT LI=  4 LJ= 12
 TYYMAX=    ,16800-01 AT LI=  4 LJ= 12  TYYMIN=  -,95200-01 AT LI=  5 LJ= 13
 TTTMAX=    ,47600-01 AT LI=  5 LJ= 13  TTTMIN=  -,84000-02 AT LI=  4 LJ= 12
   PMAX=    ,00000    AT LI=  5 LJ= 37    PMIN=    ,00000    AT LI=  5 LJ= 37

INCREASED DT TO   1,9050000-02, SMAX   2,0250002-01
DT=   1,9050-02 TIME=    1,2700-02 CYCLE=    1 S1=    1,6000-01 S2=    3,5000-01 R1=    1,5000+00 R2=    5,0000-01 COMPUT PROCESSOR
SMAX=    2,0250-01 CMAX=    0,0000    VMAX=    2,0250-01 ICMAX=  0 JCMAX=  0 IVMAX=  3 JVMAX= 12 CSMAX=    0,0000

CYCLE=    2 TIME=     3,1750-02
MASS=     2,6998-01 UMOM=     0,0000     VMOM=     5,7725-02 K,E,=     2,0746-02 I,E,=     9,0051-04 T,E,=     2,1647-02

TOTAL NEGATIVE ENERGY SUPPRESSED

CYCLE=    2 TIME=     3,1750-02
MASS=     7,7158-03 UMOM=     0,0000     VMOM=     5,8027-03 K,E,=     2,1819-03 I,E,=    -9,2047-08 T,E,=     2,1819-03
 TXXMAX=    ,91792-01 AT LI=  3 LJ= 13  TXXMIN=  -,32301-01 AT LI=  3 LJ= 12
 TYYMAX=    ,64602-01 AT LI=  3 LJ= 12  TYYMIN=  -,18358-00 AT LI=  5 LJ= 13
 TTTMAX=    ,91792-01 AT LI=  3 LJ= 13  TTTMIN=  -,32301-01 AT LI=  3 LJ= 12
   PMAX=    ,00000    AT LI=  5 LJ= 37    PMIN=    ,00000    AT LI=  5 LJ= 37
DT=   1,9050-02 TIME=    3,1750-02 CYCLE=    2 S1=    1,6000-01 S2=    3,5000-01 R1=    1,5000+00 R2=    5,0000-01 COMPUT PROCESSOR
SMAX=    2,0315-01 CMAX=    0,0000    VMAX=    2,0315-01 ICMAX=  0 JCMAX=  0 IVMAX=  5 JVMAX= 12 CSMAX=    0,0000
```

6.3 RESTART CYCLE PRINTOUT

Whenever a restart file is written onto tape a detailed printout of the problem occurs. The three pages that follow are examples of restart file printout.

The first page of printout is a display of the cell dictionary words. This is produced by subroutine PRNTCT. There are three groups of columns occurring on a page. Within a group the first two columns contain the cell indices. The dictionary subscripts are in the third column. Following this are twelve columns containing the values for the entries in the cell dictionary. For a description of the entries in the cell dictionary reference should be made to the documentation of common block CBLOCK in Section 4.

The second page of output contains the locations of the strings and string points. The columns headed by EP and DELEP are empty since strain hardening was not being performed.

All the grid and cell variable information appears on the third page of output. The first group of print contains the values of variables which are defined at the center of the regular cell. The second group of print contains the values of the lattice point variables.

In addition, the restart cycle printout usually contains the printout produced by subroutine MASFLO.

6.4 DIAGNOSTIC PRINTOUT

Diagnostic printouts may occur from time to time during the integration process. These diagnostics are intended to alert the user to possible abnormal situations. The messages produced by each subroutine are documented as part of the FORTRAN element description appearing in Section 3.2.

PURE ELAS. PROB, USING OLD PCF FOR COMPARISON WITH SOLN FROM STEEP32 SHOCK HYDRODYNAMICS, INC, STRIPE CODE 17 MAR 71 13:11:01

CYCLE= 0 TIME= 0.0000 DT= 1.2700-02 STARTR PROCESSOR

I	J	IJ	MAT	CHV	LHV	L	CNP	LNP	LOC
4	34	0227	2	2	1	1	1	1	1	0	1	0	0	000
4	37	0232	2	2	1	1	1	1	1	0	1	0	0	000
5	1	0235	0	0	0	0	0	0	0	0	0	0	0	000
5	4	0240	1	2	1	3	1	1	1	0	1	0	0	454
5	7	0243	2	2	1	1	1	1	1	0	1	0	0	000
5	10	0246	2	2	1	1	1	1	1	0	1	0	0	000
5	13	0251	2	2	1	1	1	1	1	0	1	0	0	000
5	16	0254	2	2	1	1	1	1	1	0	1	0	0	000
5	19	0257	2	2	1	1	1	1	1	0	1	0	0	000
5	22	0262	2	2	1	1	1	1	1	0	1	0	0	000
5	25	0265	2	2	1	1	1	1	1	0	1	0	0	000
5	28	0270	2	2	1	1	1	1	1	0	1	0	0	000
5	31	0273	2	2	1	1	1	1	1	0	1	0	0	000
5	34	0276	2	2	1	1	1	1	1	0	1	0	0	000
5	37	0301	2	2	1	1	1	1	1	0	1	0	0	000

I	J	IJ	MAT	CHV	LHV	L	CNP	LNP	LOC
4	35	0230	2	2	1	1	1	1	1	0	1	0	0	000
4	38	0233	1	1	0	2	0	2	0	0	1	0	0	440
5	2	0236	0	0	0	0	0	0	0	0	0	0	0	000
5	5	0241	2	2	1	1	1	1	1	0	1	0	0	000
5	8	0244	2	2	1	1	1	1	1	0	1	0	0	000
5	11	0247	2	2	1	1	1	1	1	0	1	0	0	000
5	14	0252	2	2	1	1	1	1	1	0	1	0	0	000
5	17	0255	2	2	1	1	1	1	1	0	1	0	0	000
5	20	0260	2	2	1	1	1	1	1	0	1	0	0	000
5	23	0263	2	2	1	1	1	1	1	0	1	0	0	000
5	26	0266	2	2	1	1	1	1	1	0	1	0	0	000
5	29	0271	2	2	1	1	1	1	1	0	1	0	0	000
5	32	0274	2	2	1	1	1	1	1	0	1	0	0	000
5	35	0277	2	2	1	1	1	1	1	0	1	0	0	000
5	38	0302	1	1	0	2	0	2	0	0	1	0	0	437

I	J	IJ	MAT	CHV	LHV	L	CNP	LNP	LOC
4	36	0231	2	2	1	1	1	1	1	0	1	0	0	000
4	39	0234	0	0	0	0	0	0	0	0	0	0	0	000
5	3	0237	0	1	0	0	1	3	0	0	0	0	0	453
5	6	0242	2	2	1	1	1	1	1	0	1	0	0	000
5	9	0245	2	2	1	1	1	1	1	0	1	0	0	000
5	12	0250	2	2	1	1	1	1	1	0	1	0	0	000
5	15	0253	2	2	1	1	1	1	1	0	1	0	0	000
5	18	0256	2	2	1	1	1	1	1	0	1	0	0	000
5	21	0261	2	2	1	1	1	1	1	0	1	0	0	000
5	24	0264	2	2	1	1	1	1	1	0	1	0	0	000
5	27	0267	2	2	1	1	1	1	1	0	1	0	0	000
5	30	0272	2	2	1	1	1	1	1	0	1	0	0	000
5	33	0275	2	2	1	1	1	1	1	0	1	0	0	000
5	36	0300	2	2	1	1	1	1	1	0	1	0	0	000
5	39	0303	0	0	0	0	0	0	0	0	0	0	0	000

PURE ELAS. PROB. USING OLD PCF FOR COMPARISON WITH SOLN FROM STEEP32 SHOCK HYDRODYNAMICS, INC, STRIPE CODE 17 MAR 71 13:11:01

CYCLE= 0 TIME= 0.0000 DT= 1.2700-02 STARTR PROCESSOR

STRING 1 POINTS 2

I	J	LI	LJ	X	Y,	L	EP	DELEP
5	4	5	5	8.9999998-02	9.9999999-04	1		
3	4	2	5	0.0000000	9.9999999-04	2		

STRING 2 POINTS 2

I	J	LI	LJ	X	Y,	L	EP	DELEP
3	38	2	38	0.0000000	1.1112000+00	3		
5	38	5	38	8.9999998-02	1.1112000+00	4		

FILE 1 DATE 17 MAR 71 TOD 13:11:01 BEING WRITTEN ON TAPE 8

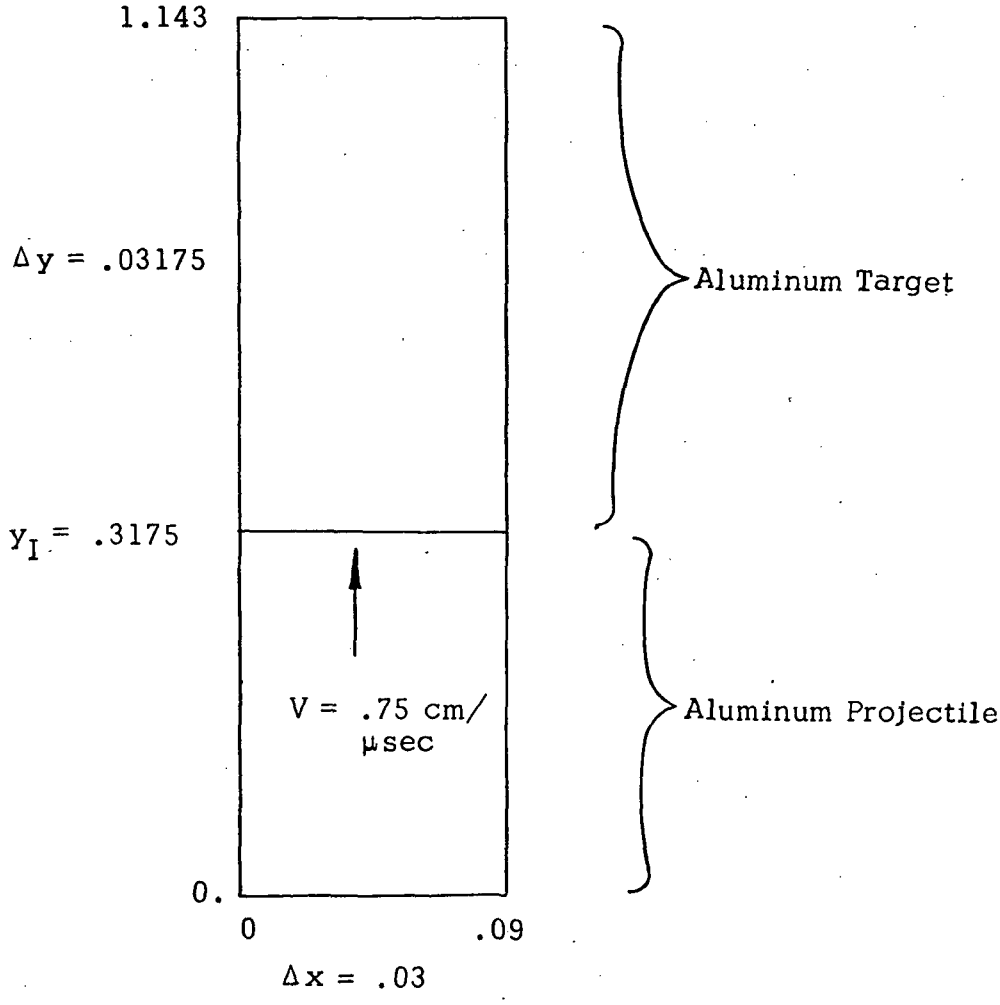
CYCLE= 0 TIME= 0.0000 DT= 1.2700-02 STARTR PROCESSOR

	I	XCM	DXCS							
C	3	1.5000-02	3.0000-02							
C IJ	J	YCM	DYCS	AREA	VOL	U	V	E	M	RHO
C 0122	4	1.5875-02	3.1750-02	9.2250-04	9.2250-04	0.0000	7.5000-01	0.0000	2.4926-03	2.7020+00
C 0123	5	4.7625-02	3.1750-02	9.5250-04	9.5250-04	0.0000	7.5000-01	0.0000	2.5737-03	2.7020+00
C 0124	6	7.9375-02	3.1750-02	9.5250-04	9.5250-04	0.0000	7.5000-01	0.0000	2.5737-03	2.7020+00
C 0125	7	1.1112-01	3.1750-02	9.5250-04	9.5250-04	0.0000	7.5000-01	0.0000	2.5737-03	2.7020+00
C 0126	8	1.4288-01	3.1750-02	9.5250-04	9.5250-04	0.0000	7.5000-01	0.0000	2.5737-03	2.7020+00
C 0127	9	1.7462-01	3.1750-02	9.5250-04	9.5250-04	0.0000	7.5000-01	0.0000	2.5737-03	2.7020+00
C 0130	10	2.0637-01	3.1750-02	9.5250-04	9.5250-04	0.0000	7.5000-01	0.0000	2.5737-03	2.7020+00
C 0131	11	2.3812-01	3.1750-02	9.5250-04	9.5250-04	0.0000	7.5000-01	0.0000	2.5737-03	2.7020+00
C 0132	12	2.6987-01	3.1750-02	9.5250-04	9.5250-04	0.0000	7.5000-01	0.0000	2.5737-03	2.7020+00
C 0133	13	3.0162-01	3.1750-02	9.5250-04	9.5250-04	0.0000	7.5000-01	0.0000	2.5737-03	2.7020+00
C 0134	14	3.3337-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0135	15	3.6513-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0136	16	3.9687-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0137	17	4.2862-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0140	18	4.6037-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0141	19	4.9212-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0142	20	5.2387-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0143	21	5.5562-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0144	22	5.8737-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0145	23	6.1912-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0146	24	6.5087-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0147	25	6.8262-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0150	26	7.1437-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0151	27	7.4612-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0152	28	7.7787-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0153	29	8.0962-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0154	30	8.4137-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0155	31	8.7312-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0156	32	9.0487-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0157	33	9.3662-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0160	34	9.6837-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0161	35	1.0001+00	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0162	36	1.0319+00	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0163	37	1.0636+00	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	2.5737-03	2.7020+00
C 0164	38	1.0954+00	3.1750-02	9.5100-04	9.5100-04	0.0000	0.0000	0.0000	2.5696-03	2.7020+00

	LI	XCS	DXCM							
L	3	3.0000-02	3.0000-02							
L LIJ	LJ	YCS	DYCM	AREA	VOL	TXX	TYY	TZZ	TXY	P+Q
L 0121	3	-0.0000	3.1750-02	4.4625-04	4.4625-04	-0.0000	-0.0000	-0.0000	0.0000	0.0000
L 0122	4	3.1750-02	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	0.0000	0.0000
L 0123	5	6.3500-02	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	0.0000	0.0000
L 0124	6	9.5250-02	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	0.0000	0.0000
L 0125	7	1.2700-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	0.0000	0.0000
L 0126	8	1.5875-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	0.0000	0.0000
L 0127	9	1.9050-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	0.0000	0.0000
L 0130	10	2.2225-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	0.0000	0.0000
L 0131	11	2.5400-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	0.0000	0.0000
L 0132	12	2.8575-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	0.0000	0.0000
L 0133	13	3.1750-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	0.0000	0.0000
L 0134	14	3.4925-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	0.0000	0.0000
L 0135	15	3.8100-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	0.0000	0.0000
L 0136	16	4.1275-01	3.1750-02	9.5250-04	9.5250-04	0.0000	0.0000	0.0000	0.0000	0.0000

SECTION 7

SAMPLE PROBLEM: 1-D ALUMINUM ON ALUMINUM IMPACT



The sample problem is a 1-D impact of an aluminum projectile $\frac{1}{8}$-inch thick on an aluminum target. The yield was set to a very large number to simulate a purely elastic material. The equation of state TBFTO2 was used.

The data on the next pages are for initial conditions, a 10 cycle integration, and an edit of the velocity vectors at cycle 0. Following the data for the edit a graph produced by the SC4020 appears.

7.1 DATA FOR THE INITIAL CONDITIONS OF THE SAMPLE PROBLEM.

```
$INITAL
  MAXCYC=100,  NPAUSE=10, NCOL=3,  NROW=52,  GEOM=1,
 LBLEFT=2,  LBRITE=2,  LBLOWR=1,  LBUPPR=1,
  BIN=8,  BOT=8,  NEWHED=.TRUE.,
 VONMIS=.TRUE.,  SIN=15,  SOU=16,
 SIN=17
 TMAX=100.,  DT=.0127,  DTMIN=.002,
 S1=.16,  S2=.35,  R1=1.5,  R2=.5,
 COEVIS=.3,
  TWOMU=.56,
  YIELD=1.E+10,
 NOX=1,  NOY=2, X=0.,.09,  DX=.03,
  NROW=37,
 Y=-.03175,1.1271,
 NREG=2, XREG=.09,.09, YLREG=0.,.3175,-.03175,
 YUREG=.31750,1.5875,
 RHOREG=2*2.702,
 PCON=2.71,4*0., 1.1867, .7630, 3.445, 1.545, .9643,.4338,.5487,1.5,
  PCON(1)=2.702,
  LFIT=1, LPOINT=1,
 DY=.03175,.03175,
 VREG=.75,
 YLREG=0.,.317,1.5875, YUREG=.318,1.5875,
$END
 PURELY ELASTIC TEST PROBLEM FOR STEEP32 INITIAL CONDITIONS
         STARTR
$BDSTRG
 NSTRG=1,
 NSTRG=2,
 XSTRG=0.,.09,
  XSTRG=.09,0.,
 YSTRG=1.E-20,1.E-20,  MSTRG=2,
  YSTRG=2*.001,2*1.1112,
  XSTRG(3)=0.,.09,
  MSTRG(2)=2,
$END
@@
```

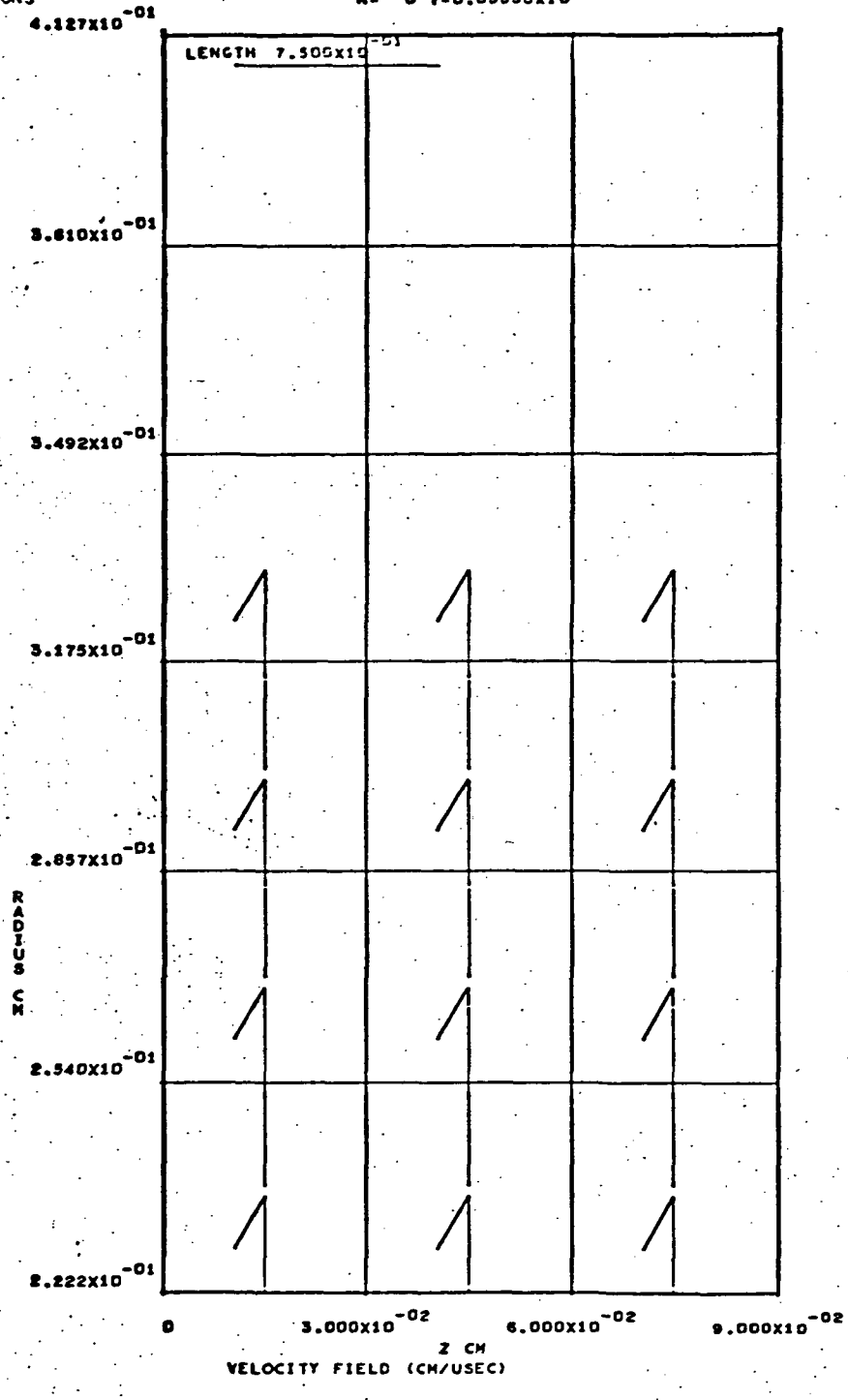
7.2 DATA FOR INTEGRATION OF THE SAMPLE PROBLEM.

```
 8  9 16 17  1
$DATAL2
 DT=.005, DTMIN=.002,  NPAUSE=10,  MAXCYC=10.  TWOMU=.56,
 NEWHED=.FALSE.,  COEVIS=0.,
 PCON=2.702,4*0.,1.1867,0.763,3.445,1.545,0.9643,0.4338,0.5487,
 1.5,
 VONMIS=.TRUE.,  SF=.FALSE.,  NIM=0,
$END
@@
```

7.3 DATA FOR EDIT OF SAMPLE PROBLEM.

```
$INITAL
 BIN=8,  CYCLE=0,  FRESH=.FALSE.,  SIN=16,  SOU=17,
$END
        EDIT
$SC4020
 PAPERT=1.,  XMIN=0.,  XMAX=.09,  YMIN=0.,  YMAX=1.0654,  DELX=.03175,
DELY=.03175, FCLASS=2,XSCALE=1.,TYPLEN=23.6,YSCALE=1.,
 YMIN=.22225,YMAX=.41275,DELX=.03,
 FMIN=0.,FSCALE=1.,
 LINEDT=.FALSE.,PLOT=.TRUE.,NGRAPH=1,NEDIT=1,DOALL=.FALSE.,
 POINTR=1,NEWHED=.FALSE.,LAST=.TRUE.,
 REW=.TRUE.,TYPLEN=.75,FSCALE=25.,
$END
              VELOCITY FIELD (CM/USEC)
   Z CM                RADIUS CM
$RSTART
$END
        CUTOFF
@@
```

ELASTIC TEST PROBLEM FOR STEEP32 INITIAL CONDITIONS N= 0 T=0.00000X10^{-01}



```
C                       SECTION 8
C
C                       GLOSSARY OF VARIABLE NAMES
C
C     ARCM(LJ)      AREA STRESS CELL SIDE LJ
C     ARCS(J)       AREA CELL SIDE J
C     AREAC(L)      AREA BOUNDARY CELL
C     AREAL(L)      AREA BOUNDARY STRESS CELL
C     BIN           RESTART INPUT TAPE
C     BOT           RESTART OUTPUT TAPE
C     C(IJ)         CELL CONTROL WORD
C     COEVIS        COEFFICIENT OF VISCOSITY FOR QUADRATIC Q
C     CMKNEN(I)     CUMULATIVE KIN ENERGY THROUGH SECTION I AT XEDIT
C     CMMGMM(I)     CUMULATIVE MOM MAGNITUDE THRU SECTION I AT XEDIT
C     CMMSEN(I)     CUMULATIVE MASS * ENERGY THRU SECTION I AT XEDIT
C     CMSPEN(I)     CUMULATIVE SPCIFC ENERGY THRU SECTION I AT XEDIT
C     CMXMOM(I)     CUMULATIVE X-MOMENTUM THROUGH SECTION I AT XEDIT
C     CMYMOM(I)     CUMULATIVE Y-MOMENTUM THROUGH SECTION I AT XEDIT
C     DEH(LJ)       HORIZONTAL SURFACE ENERGY TRANSPORT
C     DEV(LJ)       VERTICAL SURFACE ENERGY TRANSPORT
C     DMH(LJ)       HORIZONTAL SURFACE MASS TRANSPORT
C     DMV(LJ)       VERTICAL SURFACE MASS TRANSPORT
C     DUH(LJ)       HORIZONTAL SURFACE U MOMENTUM TRANSPORT
C     DUTOL         MINIMUM ABSOLUTE CHANGE IN U VELOCITY
C                   USED BY PHASEA.
C     DUV(LJ)       VERTICAL SURFACE U MOMENTUM TRANSPORT
C     DVH(LJ)       HORIZONTAL SURFACE V MOMENTUM TRANSPORT
C     DVTOL         MINIMUM ABSOLUTE CHANGE IN V VELOCITY
C                   USED BY PHASEA.
C     DVV(LJ)       VERTICAL SURFACE V MOMENTUM TRANSPORT
C     DXCM(LI)      XCM(I+1)-XCM(I)
C     DXCS(I)       XCS(LI)-XCS(LI-1)
C     DXTOL         MINIMUM ABSOLUTE POINT DISPLACEMENT IN X DIRECTION
C                   USED IN BDMOVE.
C     DYCM(LJ)      YCM(J+1)-YCM(J)
C     DYCS(J)       YCS(LJ)-YCS(LJ-1)
C     DYTOL         MINIMUM ABSOLUTE POINT DISPLACEMENT IN Y DIRECTION
C                   USED BY BDMOVE.
C     E(IJ)         SPECIFIC INTERNAL ENERGY
C     EEST(IJ)      ESTIMATED TOTAL ENERGY/MASS
C     ETOL          MINIMUM ABSOLUTE E
C                   USED BY MASFLO.
C     ETOT(IJ)      ESTIMATED TOTAL ENERGY
C     FHH(I)        HORIZONTAL FORCE ON HORIZONTAL FACE
C     FHV(J)        HORIZONTAL FORCE ON VERTICAL FACE
C     FTT           ROTATIONAL FORCE
C     FVH(I)        VERTICAL FORCE ON HORIZONTAL FACE
C     FVV(J)        VERTICAL FORCE ON VERTICAL FACE
C     GEOM          GEOMETRY. 1=SLAB, 2=CYLINDRICAL
C     I             CELL COLUMN
C     IJ            CELL SUBSCRIPT
C     IMAX          MAXIMUM CELL COLUMN
C     IMIN          MINIMUM CELL COLUMN
C     IO            CELL COLUMN OFFSET
C     J             CELL ROW
C     JMAX          MAXIMUM CELL ROW
C     JMIN          MINIMUM CELL ROW
C     JO            CELL ROW OFFSET
C     JSEN          SENSE SWITHES  0-OFF   1-ON
C     KINENG(I)     KINETIC ENERGY THRU SECTION I AT XEDIT
```

```
C     LBLEFT       LEFT BOUNDARY 1=FREE,2=FIXED
C     LBLOWR       LOWR BOUNDARY 1=FREE,2=FIXED
C     LBRITE       RITE BOUNDARY 1=FREE,2=FIXED
C     LBUPPR       UPPR BOUNDARY 1=FREE,2=FIXED
C     LFIT(K)      TYPE OF FIT FOR EQUATION OF STATE
C     LI           LATTICE COLUMN
C     LIJ          LATTICE
C     LIMAX        MAXIMUM LATTICE COLUMN
C     LIMIN        MINIMUM LATTICE COLUMN
C     LIO          LATTICE COLUMN OFFSET
C     LJ           LATTICE ROW
C     LJMAX        MAXIMUM LATTICE ROW
C     LJMIN        MINIMUM LATTICE ROW
C     LJO          LATTICE ROW OFFSET
C     LPOINT(K)    POINTER TO LOCATION OF EQUATION OF STATE CONSTANTS
C     MASS(IJ)     CELL MASS
C     MASENG(I)    MASS*ENERGY THROUGH SECTION I AT XEDIT
C     MAGMOM(I)    MOMENTUM MAG  THRU  SECTION I AT XEDIT
C     NCOL         NUMBER OF CELL COLUMNS
C     NROW         NUMBER OF CELL ROWS
C     PCON(L)      EQUATION OF STATE CONSTANTS
C     POS          TRUE IF ANY REAL STRING POINTS IN PROBLEM
C     PTOL         MINIMUM ABSOLUTE PRESSURE
C     RA(L,M,N)    MINIMUM CUT POINT OF SEGMENT
C     RB(L,M,N)    MAXIMUM CUT POINT OF SEGMENT
C     RHOTOL       MINIMUM ALGEBRAIC DENSITY (RHO=0. IF LESS THAN RHOTOL)
C                  USED BY BDMOVE.
C     SMASS(I)     MASS THROUGH SECTION I AT XEDIT
C     STTA(LIJ)    S/TT * A(N)
C     STTEST(LIJ)  ESTIMATED S/TT
C     STTH               STRESS FLOW STT ACROSS HORIZONTAL SURFACE
C     STTV               STRESS FLOW STT ACROSS VERTICAL SURFACE
C     SXXA(LIJ)    S/XX * A(N)
C     SXXEST(LIJ)  ESTIMATED S/XX
C     SXXH               STRESS FLOW SXX ACROSS HORIZONTAL SURFACE
C     SXXV               STRESS FLOW SXX ACROSS VERTICAL SURFACE
C     SYYA(LIJ)    S/YY * A(N)
C     SYYEST(LIJ)  ESTIMATED S/YY
C     SYYH               STRESS FLOW SYY ACROSS HORIZONTAL SURFACE
C     SYYV               STRESS FLOW SXY ACROSS VERTICAL SURFACE
C     TTT(LIJ)     SIGMA/THETA-THETA
C     TTTTOL       MINIMUM ABSOLUTE TTT
C     TXX(LIJ)     SIGMA/XX
C     TXXTOL       MINIMUM ABSOLUTE TXX
C     TXY(LIJ)     SIGMA/XY
C     TXYA(LIJ)    T/XY * A(N)
C     TXYEST(LIJ)  ESTIMATED T/XY
C     TXYH               STRESS FLOW TXY ACROSS HORIZONTAL SURFACE
C     TXYTOL       MINIMUM ABSOLUTE TXY
C     TXYV               STRESS FLOW TXY ACROSS VERTICAL SURFACE
C     TYY(LIJ)     SIGMA/YY
C     TYYTOL       MINIMUM ABSOLUTE TYY
C     TWOMU        2*MU FOR MATERIAL
C     U(IJ)        X VELOCITY
C     UAVE(IJ)     X VELOCITY AVERAGE
C     UEST(IJ)     X VELOCITY ESTIMATE
C     USKING(I)    KIN ENG PER STERADIAN AT XEDIT
C     USMASS(I)    MASS    PER STERADIAN AT XEDIT
C     USMGMM(I)    MOM MAG PER STERADIAN AT XEDIT
C     USMSEN(I)    MAS*ENG PER STERADIAN AT XEDIT
```

```
C     USXMOM(I)    X-MOM   PER STERADIAN AT XEDIT
C     USYMOM(I)    Y-MOM   PER STERADIAN AT XEDIT
C     UTOL         MINIMUM ABSOLUTE U
C                  USED IN MASFLO.
C     V(IJ)        Y VELOCITY
C     VAVE(IJ)     Y VELOCITY AVERAGE
C     VEST(IJ)     Y VELOCITY ESTIMATE
C     VOLC(L)      VOLUME BOUNDARY CELL
C     VOLTOL       MINIMUM VOLUME RATIO FOR ACCELERATION
C     VOLL(L)      VOLUME BOUNDARY STRESS CELL
C     VTOL         MINIMUM ABSOLUTE V
C                  USED IN MASFLO AND PHASEA.
C     XCM(I)       X CENTER OF MASS
C     XCS(LJ)      X CELL SIDE
C     XMOM(I)      X-MOMENTUM THROUGH SECTION I AT XEDIT
C     YMOM(I)      Y-MOMENTUM THROUGH SECTION I AT XEDIT
C     YCM(J)       Y CENTER OF MASS
C     YCS(LJ)      Y CELL SIDE
C     YIELD        YIELD CONSTANT
C
@@
```

SECTION 9

SUMMARY AND RECOMMENDATIONS

Under the current contract, the STEEP code has been converted to the Marshall Space Flight Center EXEC VIII system. The converted code has been designated STEEP32. This document describes STEEP32 from the User's point of view. Each major step in a STEEP32 solution is illustrated in a sample problem. There is a detailed discussion of the internal organization of the code.

To facilitate the utilization of STEEP32 by MSFC personnel it is recommended that workshop sessions be conducted. The utilization of the STEEP32 documentation to set up and run problems of current interest would be included in these sessions.

It is further recommended that provisions be made for continuing technical staff services. Such services would include additional instruction and could be extended to programming assistance in making code modifications.

Finally, additional consideration should be given to improved numerical techniques which are now available. In particular, the basic formulation of STEEP32 has been extended to multiple materials. This code is called SHESAM (an acronym for Shock Hydrodynamics Eulerian with Strength and Multiple materials). Reference 5 describes the results of an application of SHESAM to the study of debris formed by a shape charge perforation.

APPENDIX A

EQUATIONS OF STATE

Included in the following are two of the most frequently used equations of state. Additional equations of state which have been used in conjunction with codes developed by Shock Hydrodynamics Incorporated can be found in Reference 4.

EQUATION OF STATE SUBPROGRAMS SPECIFICATIONS

Nomenclature		Units*
ρ	material density	gm/cc
e	specific internal energy	10^{12} ergs/gm, $\frac{\text{Mb-cc}}{\text{gm}}$
P	pressure	megabars
c	adiabatic sound speed	cm/μ s

*with certain exceptions

Definitions

ρ_o	normal material density
e_o	rest energy
$e' = e + e_o$	
$\eta = \rho/\rho_o$	relative density
$\mu = \eta - 1$	compression
$V = 1/\rho$	specific volume
$\epsilon = \rho_o e$	energy density

Universal Constants (C(I) is first for particular fit)

C(I)	ρ_o	normal material density
C(I + 1)	c min	a) the minimum sound speed
*C(I + 2)	$\lvert\mu\rvert$ min	If ($\lvert\mu\rvert$ < C(I + 2))μ is replaced by 0; η is replaced by 1

Universal Constants (continued)

*C(I + 3)	e min	If (e < C(I + 3)), e is replaced by 0
*C(I + 4)	P min	If (P < C(I + 4)), P is replaced by 0

Inputs η, e

Outputs P, c^2 where $c^2 = \left(\frac{\partial P}{\partial \rho}\right)_e + \frac{P}{\rho^2}\left(\frac{\partial P}{\partial e}\right)_\rho$

FIT 1: LASL Metal Fit

FORM:

$$P = \frac{A + B\epsilon + C\epsilon^2}{\epsilon_o + \epsilon}$$

$$A = \mu (a_1 + a_2 |\mu|)$$

$$B = b_o + b_1 \mu + b_2 \mu^2$$

$$C = c_o + c_1 \mu$$

$$c^2 = \frac{1}{\rho_o (\epsilon_o + \epsilon)} \{A' + B'\epsilon + C'\epsilon^2 + \frac{P}{\eta^2} (B + 2C\epsilon - P)\}$$

$$A' = a_1 + 2a_2 |\mu|$$

$$B' = b_1 + 2b_2 \mu$$

$$C' = c_1$$

CONSTANTS (13)		Magnesium[1]	Aluminum[2]	Iron[2]	Beryllium[2]
C(I)	ρ_o	1.735	2.702	7.86	1.845
C(I + 5)	a_1	0.56645	1.1867	7.78	0.9512
C(I + 6)	a_2	0.33433	0.7630	31.18	0.3453
C(I + 7)	b_o	2.2178	3.455	9.591	0.9269
C(I + 8)	b_1	0.87104	1.545	15.676	2.948
C(I + 9)	b_2	0.48136	0.9643	4.634	0.5080
C(I + 10)	c_o	0.41626	0.4338	0.3984	0.5644
C(I + 11)	c_1	0.58904	0.5487	0.5306	0.6204
C(I + 12)	ϵ_o	1.5	1.5	9.0	0.8

[1] Source for MG LASL (R. K. Osborne, Letter Dated 12 Oct. 1964).

[2] Source of data: L-401, 8 Jan. 1960, R. L. Bjork, The RAND Corporation.

FIT 12: Tabular Fit 2 (Shock Hydrodynamics)

FORM: Double interpolation/extrapolation on log η, log e' ($e' = e + e_o$) in table of $P(\log \eta, \log e')$

$$c^2 = \frac{1}{\rho_o}\frac{\partial P}{\partial \eta} + \frac{\partial P}{\partial e}\frac{\partial e}{\partial \eta}$$

$$\frac{\partial P}{\partial \eta} = \frac{P(\eta_{i+1}, e') - P(\eta_i, e')}{\eta_{i+1} - \eta_i}$$

$$\frac{\partial P}{\partial e} = \frac{P(\eta, e'_{j+1}) - P(\eta, e'_j)}{e'_{j+1} - e'_j}$$

when i is such that $\eta_i \le \eta \le \eta_{i+1}$

j is such that $e'_j \le e \le e'_{j+1}$

and extrapolation is done in the usual fashion.

CONSTANTS (12 + NETA + NETA * NE)

C(I)	ρ_o
C(I+5)	α If $\alpha = 0$ and $P < P_{min}$, P is replaced by 0 If $\alpha > 0$ and $P < P_{min}$, P is replaced by P_{min}
C(I+6)	date, date of table generation
C(I+7)	e_o, free energy
C(I+8)	NETA (floating point) number of (log η)'s
C(I+9)	NE (flating point) number of (log e')'s
C(I+10)	min log e'
C(I+11)	Δlog e' (table is uniform in Δlog d')
C(I+12)	log η_1 (table allows for non-uniform log η)
C(I+13)	log η_2 etc.

CONSTANTS (12 + NETA + NETA * NE) (continued)

C(I + NETA + 11) $\log \eta_{max}$

C(I + NETA + 12) $P(\log \eta_1, \log e_1')$

C(I + NETA + 13) $P(\log \eta_2, \log e_1')$

etc.

C(I + NETA + 11 + NETA * NE) $P(\log \eta_{NETA}, \log e_{NE}')$

APPENDIX B

FORMAT OF STEEP32 RESTART TAPES

A STEEP32 restart tape consists of a sequence of logical files. Each logical file corresponds to a particular computational cycle that the STEEP user has elected to save.

Each logical file consists in turn of a sequence of logical records. Each logical record is defined by a record type. Record type 1 is a header record containing the file number of the file, the time and date it was created and the record type. All succeeding record types begin with the same format as record type 1.

Record type 2 contains the variables from common blocks CONSTS and MATBLK. Record type 3 contains common block BOUNDY. There are multiple type 4 records. The first record type 4 contains the cell dictionary. Each succeeding record type 4 contains the cell variables for a particular column. These correspond to the first twelve elements of the drum file. Record type 5 contains CUTBLK as well as the total number of allowable elements in any one of the arrays in CUTBLK. Record type 6 contains the grid coordinates XCS and YCS. There currently is no record type 7. Record type 8 is a trailer record for the file. Record type 9 is a logical end of tape record.

The STEEP32 restart tape is written using FORTRAN binary write statement.

REFERENCES

1. H. E. Read (Shock Hydrodynamics), "STRIDE, A Three-Dimensional Code," LMSC-D000017, Lockheed Missiles and Space Co. (1967).

2. M. Rosenblatt (Shock Hydrodynamics), "Analytic Study of Strain Rate Effects in Hypervelocity Impacts," prepared under NASA Contract NAS8-20235 (January 1970).

3. M. Rosenblatt, K. N. Kreyenhagen, and W. D. Romine (Shock Hydrodynamics), "Analytical Study of Debris Clouds Formed by Hypervelocity Impacts on Thin Plates," AFML-TR-68-266, AD 683 055 (December 1968).

4. M. Rosenblatt (Shock Hydrodynamics), "Numerical Calculations of Hypervelocity Impact Crater Formation in Hard and Soft Aluminum Alloys," AFML-TR-70-254 (February 1971).

5. M. Rosenblatt and W. S. Goerke (Shock Hydrodynamics), "Numerical Study of Behind-Target Debris from Shaped-Charge Perforations," prepared under Contract DAAD05-71-C-0322.